TRAINING EFFECTIVENESS EVALUATION OF DEVICE A/F37A-T59

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ABSTRACT

The 34th Tactical Airlift Training Group (TATG) at Little Rock AFB provides initial and tactical mission qualification training to C-130 crewmembers. One of the new features of the newly delivered simulators is the inclusion of Stationkeeping Equipment (SKE). A complex set of procedures for proper utilization of SKE during formation airdrops forms a large portion of the tactical mission qualification training course. The Training Programs Branch of the 34 TATG conducted a study to explore the application of the IFS to pilot and navigator training. The study was conducted using four test classes. After a standard academic course, classes of pilots and navigators were divided into test and control groups. The test groups were trained using a pre-designed simulator syllabus and their performance was measured in the aircraft. The control groups received their training only in the aircraft before completing the same performance measurement. The study results in terms of subjective and objective data showed that the IFS could reasonably support a training effectiveness ratio of approximately 0.5. The best training strategy appears to be an integration of IFS missions among flying missions and ground training rather than in one block. We recommend inclusion of the IFS in mission qualification training. We also recommend a re-evaluation of the mechanics of the proficiency advancement concept.

INTRODUCTION

Background: The 34th Tactical Airlift Training Group at Little Rock AFB is tasked to provide the DOD C-130 training to student pilots and navigators. Mission qualification training covers the areas of airdrop, formation, and shortfield operations. Student pilots and navigators learn formation procedures for both instrument and visual operations. Formations in instrument conditions rely on Stationkeeping Equipment (SKE) to maintain aircraft separation. Training SKE procedures makes up a large proportion of the curriculum.

Stationkeeping Equipment: The Intraformation Positioning Set AN/APN 169A is a system which allows up to 36 aircraft to maintain fixed separation between airplanes in formation, and to locate and identify each other during day and night flights under instrument conditions. Operation of this equipment and specialized procedures for formation flight involving pilots and navigators are the main areas of concern in this study.

Instrument Flight Simulator (IFS): In November 1980, the first C-130E flight simulator, type A/F37-AT59, was shipped from the Singer-Link Corporation, Binghamton, NY to Little Rock AFB. This technologically advanced aircrew training device (ATD) provides a training environment using a simulated C-130 aircraft cockpit. The cockpit can provide simultaneous training for a pilot, a copilot, a flight engineer and a navigator, controlled from an onboard, console-type, operators' station. The IFS is equipped with a six degree of freedom motion base which can provide highly realistic motion cues. A list of some of the simulator's other design capabilities includes full SKE airdrop simulation, radar simulation, manual or pre-programmed malfunctions, a library of demonstrations of typical maneuvers such as instrument approaches or airdrop procedures, and an emergency procedures monitor function.

Acceptance test procedures on the IFS were completed at Little Rock AFB in April 1981. The USAF Airlift Center Interim Report presents conclusions concerning IFS capabilities based on Qualification Operational Test and Evaluation (QOT&E) results (1). Some of the conclusions were: 1. The new simulator is superior to its 20 year old predecessor. 2. The new simulator is capable of training crew tasks that cannot be accomplished in the old simulator. 3. The navigator station enhances navigator training and crew coordination. Annex C of that QOT&E lists special aircrew tasks that were found to be trainable, partially trainable, or not trainable in the IFS. Among those tasks listed as trainable were: Stationkeeping Equipment checklist, SKE formation escape, SKE formation recovery, airdrop checklist, and airborne radar approaches. This information suggested that the new simulator would have direct application to pilot and navigator mission qualification training.

Summary of Primary Objectives: In June 1981, the Training Programs Branch of 34th TATG initiated a study to explore possible application of the IFS in pilot and navigator mission qualification training. Listed below are the four areas of principal concern in this study arranged in order of decreasing importance.

1. The primary objective of this study was to examine the transfer of training using this device. Positive transfer implies that as a result of training in the simulator, less time is needed in the aircraft in order to attain a predetermined performance criterion.(2, 3) 2. A second objective was to investigate possible course structures to optimize simulator effectiveness. Also under consideration was the best arrangement of the course from the point of view of efficient scheduling. 3. The third objective was to produce and prove simulator courseware and job performance aids. Since SKE procedures had never before been presented in a simulator there was no applicable courseware in existence. 4. An additional objective of the study was to determine the efficacy of the instructor training program. A further task was to establish a qualified force of instructor pilots and navigators in adequate numbers for the study.

METHOD

A number of types of training effectiveness studies were considered. The transfer of training design was determined to be the most appropriate to determine whether ATD training would improve a student's subsequent performance in the aircraft (4).

Study Design: Through the use of a transfer of training design, experimental and control groups would be evaluated both objectively and subjectively. The methodology of data gathering required that experimental groups be exposed to a pre-designed simulator syllabus and then have their performance measured in the aircraft. The control group would receive their training only in the aircraft before completing the performance measurement. There were many constraints placed upon the implementation of this experimental program.

Time and Numbers: One of the most profound limitations was the availability of simulator time. In July, utilization reached 48 hours divided into four, 12 hour days. All use of the simulator was lost after 1 Oct 81 due to installation of a visual display system. Based on this limited simulator availability four student crews each from classes 81-012, 81-014, 81-016, and 81-018 were selected as the test group. The remaining students in these classes and the student population in the intervening odd numbered classes made up the control group. The student test group was composed of 30 pilots and 15 navigators. While it would have been desirable to get a more statistically significant sample for the test group, the actual number of subjects was thus limited.

Missions: Numerous studies have shown that a training effectiveness ratio of .48 is a good average value (5). This value was used as a starting point from which planning proceeded. Based on simulator time available, frequency of class starts, and the number of days allocated for flying training, a preliminary decision was made to produce a training block of four simulator missions. Existing instructional plans were changed only in the flying phase of instruction for both pilots and navigators. For the test group, this change included four simulator missions and six flying missions followed by the standard evaluation. The planned sequence after academics became one flying mission, a block of four simulator missions, five more flying missions and an evaluation.

The simulator was designed to allow for preprogramming of mission profiles. Due to system limitations during IFS testing, this feature was not available for this study.

Subjects: The first class was conducted with students handpicked on the basis of previous C-130 experience or strong performance in the initial qualification course. With this background, they would not be hurt by any shortcomings in the initial syllabus (6, 7). Also, the best qualified students were expected to point out weak areas in the program. Students from the next three classes were chosen so that the test group would closely approximate the control group in experience and aptitude.

Data: The data collected for this study fell into one of two categories, subjective or objective.

Subjective Data: The instructor mission reports provided course developers with their first feedback for improving the course as training progressed. This report aided developers in resolving student critique items.

Students were asked to complete a critique of the simulator course before and after the flying phase of training. The critiques used a 1 to 5 numerical grading scale to rate approximately 18 course-related areas with room for comments and student data. In this way, student attitudes could be gauged before flight training to get immediate feedback on the details of the simulator curriculum. The critique administered after the flying phase was intended to indicate the student perceptions of simulator realism and how well it prepared them for their aircraft missions from the perspective of course completion.

In order to get the instructors' overall view of the course, a meeting was held on 30 Oct 81 after all simulator training was completed. The instructors had had enough time to mull over the program by the time the comments in the mission reports were raised for general discussion. A consensus was reached in each case about the validity and relative importance of each item reported. This also provided a trigger for further discussion on several topics. This meeting was the last source of subjective data considered.

Objective Data: Numerical data is extracted from student training records and evaluation worksheets. Instructors assign performance and knowledge grades based on student proficiency. The grading system spans the numerical grades 1 to 4 for performance and A to D for knowledge levels. Data on flying time and number of sorties completed can also be obtained from these forms.

Courseware: Instructor guides and student study guides are routinely distributed as a part of courseware for the academic and flying phases of training. With the addition of simulator missions, additional guides were developed for both the instructors and the students. These test guides were developed with two objectives in mind: the need to prepare students to use the simulator time effectively, and the need to adequately prepare instructors for the unique simulator training mission.

PROCEDURES

The test program will be considered in terms of two major phases: Design and Implementation. Also considered here will be the problems encountered throughout the study.

Design Phase: Course developers were first exposed to the IFS in Aug 80 on a Training Group sponsored trip to the Singer-Link plant at Binghamton, NY. During the visit, Singer-Link personnel demonstrated the capabilities and design charateristics of the cockpit simulator, the instructor onboard station, and the motion base. The developer's returned after four days with enough data to prepare a preliminary planning document in Oct 80 that outlined assumptions, a scenario for incorporating the simulator in training, a study proposal and possible mission profiles.

After the simulator arrived, it became apparent that the test profiles in the computers were unsuitable for training. It also became apparent that neither the equipment nor qualified personnel were available to reprogram the memory discs in the computer. This fact had a major effect on courseware planning and the instructor qualification program since the developers had hoped to train the instructors on the mission profiles to be later used with students.

Implementation Phase: The first mission qualification students (class 81-012) began simulator training on 23 Jun 81. The last student crews completed simulator training on 1 Oct 81 and completed the course on 26 Oct 81.

Between each of the classes, course developers made revisions to students materials as required. Course developers consolidated, printed, and distributed additional techniques covering simulator operation and failure trends. Training time was saved as the instructors were made aware of the experiences that preceding instructors documented on the mission reports. In general, all possible aids were provided and improved throughout the program to insure peak efficiency of student training and maximum instructor acceptance of the program.

All students considered in this study attended the standard academic training program. For pilots, this meant five days of academics followed by an initial flying mission and then a final academic day. For the navigators, there were eight days in academics and then the first flight mission. Following academics, the students who made up the control group flew a scheduled program of eight missions and a flight evaluation. The actual number of missions an individual completed varied.

Upon completion of academics, the simulator group began a block of four simulator missions of four hours each. The actual number of days needed to complete this training varied due to simulator availability. There was some flexibility built into the profiles to allow the instructors to concentrate training on individual student weaknesses.

At the end of the simulator phase, the simulator students flew a program of six flying missions and a checkride. The test program called for these training flights to concentrate on low level visual procedures. To accomplish this, the test group and the control group would fly in separate formations during the flying phase. After the test group's fourth flying mission, the two groups could be integrated into the same formation in order that the test group fly in SKE formations as a review prior to their checkrides. This plan proved largely unworkable for operational reasons, so the flight mission profiles flown were essentially the same for both groups.

Problems Encountered: Other than the resistance to change anticipated in a significant alteration of training, the following major problem areas were encountered during the test program: simulator maintenance, instructor attrition, and scheduling as it affected profile changes and proficiency advancement. These problems existed during the entire test program, and although they were overcome to the extent that the program was completed, they will continue to impact any full-scale incorporation of the simulator into mission qualification training. The background and impact of the problem areas will be considered here; possible solutions can be found in the Recommendations section.

Simulator Maintenance: The most obvious problem that arises when trying to create a new training syllabus, simultaneously with full-scale development of an ATD, is building a core of knowledge about the device. In the case of IFS maintenance, this was particularly true. The manning level had been fixed at a number of personnel to maintain the four old analog simulators plus two new devices. During the study period, this manning was required to maintain the four old simulators, the new IFS, and two Cockpit Procedures Trainers. Additionally there was a requirement to retrain maintenance personnel from analog to digital logic.

One area of maintenance particularly affected by manning and training was simulator software. During the study period there were literally hundreds of software deficiencies the status of which was still unresolved between Singer-Link, Aeronautical Systems Division (ASD), and the Data Base Engineering Prototype Site (DEPS) personnel. Due to the manning limitations and training level of those assigned to DEPS, very few discrepancies were corrected during the study period. Instructors were forced to ignore and train around the vast majority of software errors.

Instructor Attrition: In order that the test program have a fair chance for success, qualified and motivated instructors were required. In the inital stages of the program, experienced and motivated instructors were hand picked to attend the Simulator Instructor Course (SIC). The intention was to use the same instructors during the entire period to eliminate the variable of differing instructor abilities from the transfer of training study. There was no problem retaining qualified instructor navigators in the test program, but this was not true of instructor pilots.

The instructor continuity policy, two week class start interval, tight summer manning and instructor pilot losses combined to severely limit the number of available simulator qualified instructors. Although the test plan recommended the use of the same instructors as much as possible to eliminate variability of instruction, this was not feasible for the pilots. Considerable extra effort was required to train replacements within the minimal amount of remaining time available on the device. In contrast to the pilot situation, the instructor navigator force remained relatively stable.

Scheduling and Profile Changes: Another variable that course developers endeavored to hold constant was the content of the flying mission profiles. From the third mission through evaluation, the profile contains a SKE formation route, airdrop and approach followed by two visual formation low level routes, airdrops and visual recoveries. The test program differed from the existing profiles beginning at mission three. Missions three and four were proposed to be visual formation missions to balance the heavy SKE emphasis of four simulator missions. The remaining missions and the evaluation were to concentrate on SKE/visual profiles with the intent being balanced mission emphasis prior to the evaluation and course completion.

The profiles actually flown during the test program did not adhere closely to the guidelines for either the normal or the test program profiles. During the test classes, it was impossible to fly the test group independently of the control group. Only infrequently did all the test group aircrews make up a formation for which only visual formation events were planned. Discussion of the effects of the heavy emphasis on SKE by the test group will be considered under the Conclusions section.

The end result was that although course developers had hoped to test a specific sequence of simulator and flying missions, scheduling produced a hybrid sequence of missions based on what existed and what was desired. The all-visual missions of the test group were never realized. Seven rather than six missions were actually flown, as a rule.

Scheduling and Proficiency Advancement: The courses administered by this training group operate under the concept of "proficiency advancement". Proficiency advancement is an operating theory under which each student must demonstrate proficiency at a task before he or she can advance to the next phase of training or be recommended for evaluation. The lack of true proficiency advancement was found to be based on a limited flexibility in the scheduling of flying time, constraints arising from simultaneous training in multiple crew positions, an informal instructor rating system, and the constraints associated with accomplishing training events. These factors tend to discourage proficiency advancement and cause the vast majority of students to fly about the same amount of time each class. This problem is further discussed in Conclusions.

RESULTS

The results of the test program will be presented in two parts. The first part will deal with the students and the second part will consider the instructors. While there is some overlap in these two areas, for the most part, they are distinct topics.

Students: The test program encompassed 30 student pilots and 15 student navigators. The data compiled on these test subjects and the control group will be presented here.

The pilot students were well qualified with an average of 2118 flying hours (1631 hrs C-130). The copilots were mostly recent UPT graduates with an average of 438 total hours (42 hrs C-130). The navigators had a mix of experience levels ranging from 7000 hours to 140 hours with a total flying average of 1924 hours (650 hrs C-130).

Students completed critiques which rated individual areas of course design and effectiveness. A five point scale was employed with catagories labeled from "poor" to "outstanding". Critiques were completed at the end of both the simulator and flying phases. The ratings were consistently excellent to outstanding in most areas. Of particular interest were the overall ratings (pilot and navigator responses combined) at the end of the flying phase. Seventy-six percent of the students rated the simulator excellent or outstanding as a transition to the aircraft. Sixty-nine percent of the students similarly rated the program outstanding as a transition to the flying phase.

In addition to the ratings, the students made comments on the critique forms. Some of the comments dealt with suggested changes in the missions, such as more or fewer malfunctions. These suggestions were acted upon when feasible. The size of the list was deceptively long. Some of the comments were contradictory and thus their validity is suspect. For instance, some students in class 81-016 recommended elimination of SKE lead time while others recommended an increase. The remainder of the unresolved comments will be studied further to improve the syllabus. The largest comment area was praise for the course as beneficial.

Averages for the number of sorties and flying time expended for training classes during the summer of 1981 were tabulated. The results show that the test groups experienced fewer average sorties and flying time than the control groups, but not by the margin hypothesized in the Method section. This information is summarized under Program Averages (figure 1). It should be noted for class 81-014 and 81-016 that, although the students completed training with fewer flying hours and number of sorties, the test group required more training days than the control group. The cause of this anomaly can be traced to the profile changes, and the effect of the increased number of training events generated by the use of the ATD (discussed under Conclusions).

A complete listing of all the control group flight evaluation discrepancies was compiled for pilots and navigators respectively. A comparison was made of discrepancy areas and frequencies between test and control groups of pilots and navigators. This data shows significantly fewer discrepancies in the test group for SKE enroute formation position for pilots. SKE departure and SKE recovery discrepancy rates are approximately the same for control and test groups in relation to respective populations. No trend can be seen in navigator discrepancies when comparing test and control groups except in the area of SKE knowledge and use. Overall, SKE knowledge and formation position flying discrepancies appear to be reduced by the inclusion of IFS missions in the syllabus.

Also in figure 1, the overall percentages show that test group pilot and navigator students completed training without discrepancies more often than those in the control group. The test group accomplished this with fewer flying sorties and hours. There seems to be an insignificant difference in the number of days in training between test and control groups for the pilots. The navigators, in contrast, show a difference of about four days. The significance of all these areas with reference to the utility of the ATD with be further discussed in Conclusions.

Instructors: Based on the Instructor Mission Report ratings there seems to be no identifiable trend to the usage pattern of the simulator. Reliability rates for the device will be discussed later in this section. The instructor pilots and navigators indicated their perceptions of device operation and training value with a numerical rating. The data generally reflects a "good" rating for device operation and a "good" to "excellent" rating for training accomplished. There is a high correlation between the device operation rating and the training accomplished rating.

In addition to the ratings, the instructor comments were compiled from the instructor mission reports. Also tabulated were the frequency of the comment, area of responsibility and the status. Numbers of comments declined over the course of the test as the program was "debugged". A listing of maintenance related comments extracted from all of the instructor mission reports was correlated with frequency of occurrence and numbers of ineffective sorties. The data shows that of the 60 simulator periods required to support 15 student crews (3 classes x 4 crews x 4 missions + 1 class x 4 crews x 3 missions), 10 periods were lost and had to be rescheduled for an overall ineffective rate of 17%. There seems to be a decline in the number of maintenance related comments over the course of the program, but the number of ineffective sorties seems constant. The predominant maintenance problem varied from class to class. For instance, hydraulic control loading was a problem during class 81-014 while motion platform jerking and software problems affected classes 81-016 and 81-018 respectively. The problems listed are fairly evenly distributed between hardware and software. Additional training time was lost or the content degraded by less significant equipment malfunctions that went unrecorded.

As with the unresolved student comments, some instructor comments on the same topic are contradictory and their validity is questionable. To resolve these contradictions and other comments, an after action meeting was held on 30 Oct 81 with all available instructors. The remainder of the comments will also be studied further to improve the syllabus and operations/maintenance interaction.

PROGRAM AVERAGES

Statistical Area	PILOTS Test Group	PILOTS Control Group	NAVIGATORS Test Group	NAVIGATORS Control Group
Ranks				
2LT	9	45	8	13
1LT	1	7	0	2
CAPT	15	37	1	4
MAJ	4	16	4	1
LTC	1	5	2	0
TOTAL NO. OF SUBJECTS	30	110	15	20
SORTIES PRIOR TO RECOMMENDATION	7.2	8.8	7.6	8.4
HOURS PRIOR TO RECOMMENDATION	32.1	38.0	N/A*	N/A*
# OF DAYS TO COMPLETE FLY PHASE	20.7	20.3	22.6	18.3
CHECKRIDE RESULTS				
Q-1	26 - 87%	79 - 72%	11 - 73%	14 - 70%
Q-1/2	1 - 03%	21 - 19%	0 - 00%	3 - 15%
Q-2	3 - 10%	6 - 05%	1 - 06%	1 - 05%
Q-3	0 - 00%	4 - 04%	3 - 20%	2 - 10%

* Data not available. Not considered relevant due to use of only pilot data for flying program scheduling.

Figure 1

CONCLUSIONS

Primary Findings

Transfer of Training: A transfer of training ratio of .48 was originally hypothesized. Based on a program of four simulator missions, this rate would suggest an approximate savings of two flight missions while holding training standards constant. The subjective and objective data collected by this study, with some qualification, support the hypothesis.

The overall flight evaluation results (see figure 1) clearly show that Q-1 rates were not degraded with the adoption of the ATD. The pilot data even suggests a slight improvement in this rate. In the specific subareas related to SKE procedures there was a significant improvement for both pilots and navigators. For pilots there was a 59% decrease in the number of SKE related discrepancies. For navigators there was a 100% decrease (the actual number of discrepancies declined from two to zero).
The number of aircraft missions flown prior to evaluation (sorties use rate) also declined with the addition of the ATD. The decrease was 1.6 and .8 sorties for the pilots and navigators respectively. Although this decrease does not fully support the hypothesised transfer of training rate, there is evidence that this rate was adversely affected by factors unrelated to training. This subject will be discussed under Weaknesses of the Study in this section.

Student and instructor feedback, as derived from critiques and mission reports, strongly supported the use of the ATD for SKE training. On 30 Oct 81 an after action meeting was held with all available instructors who had participated in the SKE test. The consensus recommendation for future simulator use was a program of four simulator missions and six or seven flying missions plus a flight evaluation.

Course Structure: Data from this study suggests that a block of simulator missions is not the most effective or efficient structure for use of the ATD.

The addition of simulator missions to the training program increases the total number of training events in the flying training phase from fourteen to sixteen. This increase in the number of events caused an increase in the number of days required by the test group to complete the course (see figure 1). In the interests of safety, instructors are usually restricted to a maximum of three actual flying missions per week. By integrating simulator missions in the flying phase the greatest number of training events can be accomplished in the time allotted.

The integrated structure may also be the most effective use of the ATD from a transfer of training point of view. Instructors noted a weakness in the blocked schedule used for the test. The test plan called for a sequence of two visual flight missions, four SKE simulator missions, then the remaining flying missions.

Instructors pointed out that students were inclined to forget visual procedures during the concentration on SKE in the simulator. Instructors felt an integrated approach would make better use of all missions. This was the recommendation of the instructors attending the after action meeting.

Courseware: Courseware included a variety of guides and job aids designed to assist the students and instructors in the use of the ATD. One of the objectives of this study was to prove these support materials. To some degree this effort was hampered because much of the courseware was revised in response to student and instructor comment during the test. Thus, the courseware as an independent test variable was not held constant. However, based on positive feedback from instructors and students, plus the positive transfer of training rate for the program, the test basically proved the efficiency and validity of the materials. Further testing for validation is suggested under Recommendations.

Instructor Training: Sufficient simulator instructors were qualified to complete the study. There was no specific data collected on the relative competence of these instructors but it may be assumed from the positive overall study results that minimum competence was attained. There were two programs used for instructor qualification. The first was a highly structured program including an academic block and a hands-on training block. The instructor's after action meeting recommended specific improvements to this program. They are: 1. Reduce the length of the academic phase, 2. Increase the amount of hands-on training, and 3. During hands-on training, include training missions with actual students. A less formal check out program was used to make up for instructor attrition during the test. This program involved "piggy backing" instructor candidates on training missions with fully qualified instructors. Although this program is less desirable than the first, it did meet the need for qualified instructors.

Additional Findings

Maintenance Support: ATD maintenance had a major impact on the test program. The test was hampered by hardware and software deficiencies throughout its run. Some deficiencies were the result of incorrect initial design while others were due to maintenance manning and skill levels.

Some deficiencies remain uncorrected due to the low maintenance manning and training levels which currently exist. Manning levels for the IFS will improve as the old simulators are decommissioned. It is to be hoped that knowledge levels in the maintenance ranks will increase with the conversion of personnel from analog to digital systems and with more experience maintaining this device.

Training Capabilities: Some important training capabilities were not designed into the ATD. For instance, one important training task is the performance of SKE procedure turn recoveries in the wing position. A capability of the simulator to train this task was never contracted for and thus never designed. As another example, trainers desired to use the concept of "backward chaining". This concept refers to a way of training a task which is made up of a series of chained subtasks. The final subtask is practiced first, then the last two subtasks, then the last three, and so on until the entire task is practiced. This concept works particularly well when the last subtask is the most difficult, since the last subtask is the most practiced. In airdrop training, the final subtasks are the most difficult to master and thus this technique could have proved very useful. However, the design of the SKE computer program required the triggers of a departure, climb, descent and slowdown in order to make an airdrop. Multiple approaches to the drop zone cannot be accomplished without flying an entire route. At some future date this basic programming may be rewritten, but these training events cannot be accomplished at this time.

In addition to deficiencies in the design and initial programming of the device, some other features of the device were unuseable. The automatic profiles, performance measurement, prerecorded demonstrations and auto message features all had a questionable reliability record. Their intermittent operation caused a degree of frustration in the instructor ranks. A large number of software changes will be required before these features are useable.

The user/trainer should not expect perfect performance from a prototype ATD during the installation and testing phase. Eventually, logistic and maintenance support should meet expectations. Long procurement lead times are to be expected on software and hardware items for a new device. The procurement contract clauses that specified testing in the plant and at the site and a data freeze date of 1977 may have provided some protection from defect in the ATD, but they also extended the time at which maintenance and logistic support will catch up with desired training quality.

Weaknesses of the Study: In the method section, the course developers proposed to extract results from the grade sheets to support collection of objective data. This was not done because of the limited value of this data. Whenever an evaluator remembered to complete the evaluation column of this form, all areas applicable to SKE formation position and procedures were usually graded at the minimum level of proficiency. The few evaluators who avoided this central tendency and showed some variation in performance and knowledge levels do not represent a numerically significant group for study.

This study has limited value because of the manner in which the objective data was collected. In the pilot mission qualification course, there are no specified criteria for the required level of proficiency in flying the SKE wing position. This position is flown 4,000 feet in trail for the number 2 wingman and 8,000 feet in trail for number 3. A criteria such as "maintain 4,000 feet in trail as number 2 wingman ± 1,000 feet" does not exist. There are no specified limits in MACR 60-1, Aircrew Standardization Evaluation Program, in relation to acceptable limits of formation position. The SKE subareas on the evaluator work sheet are graded satisfactory or unsatisfactory. For this study, course developers have been forced to rely on subjective evaluator judgements of formation position and use the checkride pass/fail rates as objective data.

The control of variables was a major weakness of this study. Too many conditions in the training program were allowed to change over the course of the test. Training profiles, numbers of sorties, instructor personnel and other proposed parameters discussed under Problems and Results varied significantly. The test program missions in the new simulator were developed to complement the existing flying program. If the simulator had been an established training device, a change in training policy would have required validation of a modified flying program. Neither of these approaches is optimal. A training syllabus that teaches required tasks should be prepared and then training time apportioned to the ATD's or flying training based on the most effective and efficient utilization of these resources. Exercise of control over all phases of the training program design would have insured more accurate test results.

Two additional weak areas deserve discussion: proficiency advancement and the small number of test subjects. As discussed under Procedures, advancement was adversely affected by current scheduling practices. As discussed in this section, proficiency is rather ill-defined and event oriented. When the student has flown all the required events listed on the grade sheet on the required number of flying missions established by the Course Summary Document, he is generally considered proficient. In examining the term "proficiency advancement", as it was applied to the test program, it is evident that "proficiency" was a subjective evaluation with little basis in objective fact and that "advancement" was inflexibly based on their student's flying schedule. Neither of these problems could be overcome in the test program methodology by the relatively small number of test subjects. See Recommendations for applicability to future syllabi and any further investigations.

Instructor Utilization: A final point to ensure continued training effectiveness of this ATD is the single instructor concept. Even though this variable has not been adequately studied, there appears to be an increase in effectiveness when a single instructor is responsible for both simulator and flying training. This allows instruction given in the simulator to be more compatible with that given in the aircraft. This should reduce any possible negative transfer that could occur as a result of instructor idiosyncrasies (8).

Recommendations

Primary Recommendations: Until a significant amount of further data can be compiled from students in a mission training curriculum incorporating the IFS, the following recommendations are made regarding that curriculum:

(1) The IFS provides good initial Stationkeeping Equipment training and should be integrated throughout the flying phase of instruction.

(2) The course of instruction for pilots and navigators following academics should consist of four simulator missions interspersed with six flight missions and an evaluation.

(3) The simulator instructor candidates should receive one day of academic training, two simulator missions without students, three training missions with students and an evaluation (if required). Instructor training should be accomplished using the training syllabus for the instructor's course (9).

(4) The courseware that was developed for this test program should be formalized and used until validation on a statistically significant student population is completed.

(5) Greater emphasis on true proficiency advancement should be supported by managers and supervisors. Training should be less event oriented and scheduling handled with more flexibility.

Additional Recommendations: The following recommendations are of less immediate importance, but should also be implemented:

(1) Specific performance criteria should be established for tasks trained in simulator and flying training for the purpose of testing and validation. These criteria will promote standardized evaluation of student performance by instructors and evaluators.

(2) Continuing studies should investigate the rate of proficiency attainment in simulator and flying training to identify the best media for instruction.

(3) Adequate ATD time should be allocated for course development efforts.

(4) Continuing efforts should be made to improve ATD maintenance support and ATD reliability.

(5) A concerted effort should be made to improve IFS software so that all design capabilities of the device are fully useable.

Refining these features will ease instructor workloads.

(6) Every effort should be made to increase supervisory awareness and support for test programs and validation studies.

(7) Standardization and Evaluation should recognize the effectiveness of this device for student training as described in this report or conduct their own validity assessment.

It is through periodic management reviews and studies of this type that training policies are examined and constructive changes made to improve training techniques.

REFERENCES

1. Interim Report - MAC Project 25-4-78 OT&E, USAF Airlift Center, July 1981, pp. C-2.

2. Laughery, Dirzian and Houtman, "Differences Between Transfer Effectiveness and Student Performance Evaluations on Simulators: Theory and Practices of Evaluations," Proceeding of Third Interservice/Industry Training Equipment Conference and Exhibition, Orlando, Nov 1981, pp. 215.

3. Mayer, Geroge B. Jr., Determining the Training Effectiveness and Cost-effectiveness of Visual Flight Simulators for Military Aircraft. Thesis for Naval Postgraduate School, June 1981, pp. 58.

4. Caro, Shelnutt and Spears, Aircrew Training Devices: Utilization, Seville Research Corporation, Jan 1981, pp. 111.

5. Orlansky and String, "Reaping the Benefits of Flight Simulator," Defense Management Journal, Fourth Quarter 1980, pp. 8.

6. *Air Force Pamphlet 50-58, Handbook for* Designers of Instructional Systems, Vol. IV, "Training", 15 Jul 78, pp. 6-11.

7. Butler, F.C., Instructional Systems Development For Vocational and Technical Training, Educational Technology Publications, 1972, pp. 144-145.

8. Op. Cit., Mayer, pp. 68.

9. Op. Cit., Caro, Shelnutt and Spears, pp. 88.

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