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Preliminary investigation of education transfer from simulator to aircraft

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ABSTRACT: In this article, the authors discuss the outcomes of the preliminary investigation of the Knowledge-based intelligent engineering Approach to the Assessment of Transfer of Training from the simulator to the aircraft project (KAATT). The KAATT Project is part of the larger Crew-Centred Flight Training (CCFT) Project. The simulator that was used was an Elite Evolution iGate 612. This simulator utilised advanced three-channel graphics that were projected on the surroundings by three video projectors. Students were educated in ab-initio crew-centred behaviours and technical flight skills in the simulator prior to transferring to the aircraft. Students then transferred to the aircraft to continue training in the basic crew-centred behaviours and technical flight skills. Students were assessed twice: after 30 hours and after 50 hours, and they were assessed as better than average at both the 30-hour assessment and the 50-hour assessment. However, there were elements of the flight test where students performed below average. This revealed that, although on the whole, students performed better than normal, there were problems with the transfer of some educational elements.

INTRODUCTION

A review of the aviation psychology or human factors literature provides general consensus that some 70% of all aircraft accidents have human error as a causal factor [3][4]. These accidents are, more often than not, the result of a breakdown in the processes of crew communication and coordination [5]. Thatcher, in an effort to reduce these human factors-related accidents, has suggested that training in crew beneficial behaviours should be introduced early in a pilot's training, that is during the primary phases of flight training or the ab-initio stage [6][7]. Thatcher has argued that training in positive crew behaviours at an early stage of training would promote well entrenched crew-beneficial behaviours. These behaviours would resist decay and, therefore, would be more likely to be manifested in times of high arousal, such as emergency or life threatening situations. Thatcher has developed Crew-Centred Flight Training (CCFT) as a methodology to achieve this outcome [5].

Flight training has historically used a traditional pedagogical approach. Further, there is no doubt that this approach to flight instruction has achieved a high level of technical proficiency among flight crew. For this reason, the techniques and methodology of flight instruction have remained relatively unchanged and unchallenged. Unfortunately, given the complex multi-crew environment in modern airline operations, it is no longer considered *safe* for an individual to be only technically competent, it is also necessary for an individual to be psychologically competent. Psychological competence includes that a member of the flight crew must have learned positive crew attitudes and behaviours.

In this article, the authors introduce the CCFT methodology, which incorporates human factors or crew resource management (CRM) as an integral part of the educational process, rather than as a separate curriculum item [2]. The Knowledge-based intelligent engineering Approach to the Assessment of Transfer of Training from the simulator to the aircraft project (KAATT) project is also discussed and the preliminary results presented [1].

CREW-CENTRED FLIGHT TRAINING

The aim of the Crew-Centred Flight Training methodology is as follows:

> *… to provide a nurturing environment in which a pilot can learn to be safe and proficient in the technical aspects of flying, and more importantly, learn the educational and team processes, embodied in the training, which will provide a foundation for further development* [6][7].

The central guiding principle of CCFT is the establishment of a student-instructor team (or crew) that focuses on the aim of the flight lesson and takes responsibility for the student's learning and development. Traditionally, ab-initio flight training has been mediated using an instructor-centred approach with the instructor focusing on the aim and taking responsibility for the student's progress. As a consequence, the student is dependent upon the instructor for learning outcomes and is preoccupied with learning the technical aspects of the flight lesson. Given this environment, it is difficult for a student to recognise and learn the educational and team processes embodied in the flight training.

This traditional model of flight training employs a pedagogical approach and is based on two assumptions about student pilots, as follows:

- *The need to know*: Learners only need to know that they must learn what the teacher teaches if they want to pass and get promoted;

- *The learner's self-concept*: The teacher's concept of the learner is that of a dependant personality [8].

These assumptions are instructor-centred or instructor-dependent. A student's prior experience is not considered to be relevant to the learning task, and a student's motivation and readiness to learn is largely dependent upon the instructor. The skill or knowledge learned is taught as discrete components that will probably be applied sometime in the future. Furthermore, an instructor-centred or pedagogical model assigns to the instructor the full responsibility for decisions about what will be learned, how it will be learned and the assessment as to whether it has been learned or not. The educational relationship is instructor-focused and instructor-directed, rather than crew-focused or crew-directed. The student pilot is forced to take on a dependent role in the learning relationship that is based on following an instructor's directions in order to elicit an instructor's reward.

The CCFT methodology utilises an andragogical (adult education) approach that assumes students are assertive and self-directing, that their *need to know* will be determined by the crew based on the student's requirements. The student's input to the learning process is regarded as vital and the crew's assessment of the student's readiness and motivation to learn is based on the student's developmental level. The material to be learned is taught as solutions to real problems and situations that have applications in the present, rather than the future. This is mediated through scenario-based training.

Therefore, in the CCFT model, the instructor-student crew has mutual responsibility for decisions regarding what, how and when knowledge and skills are learned. Student assessment and further training is mutually negotiated by the crew. In CCFT, the flight instructor adopts the role of flight facilitator and facilitates student learning within the flight environment.

KNOWLEDGE-BASED INTELLIGENT ENGINEERING APPROACH TO THE ASSESSMENT OF TRANSFER OF TRAINING FROM THE SIMULATOR TO THE AIRCRAFT

The use of flight simulators has become important in the training of pilots for essentially two reasons, namely:

- Flight training is more cost effective on the simulator because it is cheaper and safer to operate than the real aircraft;
- Flight training is more educationally effective on the simulator because the flight lesson can be stopped, reviewed and repeated.

For these reasons, the Aviation Education, Research and Operations Laboratory (AERO Lab) will utilise an A$100,000 synthetic flight training device (flight simulator), which was recently installed in the School of Electrical and Information Engineering at the University of South Australia (UniSA), Adelaide, Australia.

The Knowledge-based Intelligent Engineering Approach to the Assessment of Transfer of Training from the Simulator to the Aircraft Project (KAATT) being undertaken principally by Ong-Aree (as part of a Masters Degree by Research) is an extension of the CCFT Project being implemented at the UniSA by Thatcher, Fyfe and Jones [1]. Essentially, the KAATT project will use the flight simulator to adopt the CCFT methodology within the flight simulator training environment.

The KAATT project, in a coordinated approach with the larger CCFT project, will utilise training data gathered from the synthetic flight training device (FTD). The data from the FTD, together with data derived from the aircraft, will provide all the data required for the assessment of the transfer of training from the simulator to the actual aircraft. KAATT will use scenario-based training to create a database of student behavioural markers. These behavioural markers will be used to assess whether training in the simulator transfers accurately to the aircraft. If the training transfers positively and with high fidelity, the FTD can be used for a larger segment of the ab-initio flight training syllabus. This has obvious benefits, such as increased educational and financial efficiency.

PRELIMINARY INVESTIGATION OF THE TRANSFER OF TRAINING FROM THE SIMULATOR TO THE AIRCRAFT

A group of 16 first year ab-initio aviation students were introduced to the simulators prior to their commencement of flight training on the aircraft. The simulators or flight training devices (FTDs) used were an Elite Version 8.0 Basic Flight Training Device (Figure 1) and an Elite Evolution iGate S612 with high resolution three channel video graphics (Figure 2).

Figure 1: Elite Version 8.0 basic flight training device.

Figure 2: Elite Evolution iGate S612.

Students undertook the first five flight lessons of the degree flight training syllabus on the FTDs. Normally, these lessons are conducted in the aircraft, a PA28 Piper Warrior (Figure 3).

Figure 3: Piper Warrior PA28.

Figure 4: Elite Evolution iGate S612 showing visual resolution.

These lessons included taxiing, effects of controls, straight and level, climbing and descending, and turning. After students had reached competence in all five lessons, they were introduced to the aircraft. They continued with the flight lessons as required until they were assessed at the 30-hour stage and later at the 50-hour stage.

Initial Flight Training on the Flight Training Devices

Sixteen students each completed three hours in the Elite Version 8.0 Basic Flight Training Device (FTD) (Figure 1). During the three hours of simulator training, they were instructed in the operation and effect of controls, straight and level flight at various indicated airspeeds, medium angle of bank turns, plus climbing and descending at standard rates.

Each element of the flight lesson was integrated into basic manoeuvre patterns. These included climbing at 500 feet per minute (fpm), then a climbing turn at Rate 1 (three degrees of heading change per second) through a heading change of 90 degrees to arrive at a nominated altitude, then descending at 500 fpm while turning at Rate 1 through 90 degrees of heading change to arrive at a lower nominated altitude.

Following this flight training sequence, each of the 16 students completed three hours of flight training in an Advanced Flight Training Device, an Elite Evolution iGate S612 Simulator (shown in Figures 2 and 4).

The training exercises undertaken in the Basic FTD were repeated in the Advanced FTD.

Following training on the FTDs the students transferred to the aircraft (Figure 3) to complete Cockpit Procedures Training (CPT) in the form of 3 x 0.5 hour lessons. The first session dealt with pre flight inspections and cockpit orientation and the second and third sessions included start, taxi, engine run-up, Take-Off Checklists followed by After Landing Checklist, taxi, parking and shutdown procedures.

The students then commenced flight training proper on the fourth lesson. This lesson comprised of aircraft and training area familiarisation and revision of all simulator sequences.

RESULTS

Student Performance on the FTDs

A criterion referenced, competence-based assessment was utilised after each flight lesson. The standard for each of the specific manoeuvres taught was assessed as competent if a student was able to conduct the manoeuvre within ±10º for heading; ±100 feet for altitude; and ±10 knots for airspeed.

One area of aircraft control that was difficult to assess was the use of rudder to maintain balance. The nature of the simulator rudder control response proved problematic in that there was insufficient damping in the control system. This had the tendency to discourage students from applying the appropriate rudder forces due to over-reaction in the rudder control system, which resulted in exaggerated aircraft behaviour. As a consequence, the students' training focused primarily on the coordinated use of the flight controls in the basic aircraft manoeuvres.

All students were assessed as competent and transitioned to the training aircraft (Figure 3).

Student Performance on the Aircraft

30-Hour Check Flight

After 30 hours of aircraft flight time, the students in the group were tested to determine whether or not they met the required competence for each of the aircraft manoeuvres. The standard for competence was the same standard used in the FTD environment. However, extra flight sequences, including steep turns, practice forced landing, normal and abnormal circuits, were also assessed at this stage.

All students performed above average on the check flight and demonstrated a marked improvement over the previous year's students. However, there were elements of the check flight where students performed below expectation based on comparisons with the previous year's students. These elements included; lookout, use of rudder to balance the aircraft, excessive use of instruments and radio communication skills.

50-Hour Check Flight

Several of the students have undertaken 50 hour check flights for the General Flying Progress Test, a regulatory basic handling flight test. While the sample of students was small (only ¼ of the student sample), there was a strong inference that those students who started their training in the FTDs performed better than the previous year's students who had started their training in the aircraft. This is particularly noticeable in such flight sequences as instrument flying and basic attitude flying.

However, while individual flying skills seem to have been enhanced as a result of having their first lessons in the FTDs, other elements, important to a student's development of airmanship, were weakened. Two areas of concern were lookout both prior to entering, and during, the flight manoeuvres, and continually flying on instruments, rather than looking out the window for visual cues. Indeed, visual cues are the primary reference when flying under the visual flight rules (VFR).

CONCLUSION

This preliminary study was initiated to ascertain whether students could be initially trained in the FTD and then transfer them to the aircraft with a high level of transfer of training. The study revealed that crew behaviours, such as checking of checklists and aircraft procedures, were transferred with a high level of fidelity. Instrument flying skills and basic flying were also well transferred. However, certain elements transferred negatively. These included an over-reliance on instruments and poor look out skills. Also, the use of the rudder transferred negatively to the aircraft, probably as a result of the control problems discussed above.

A further problem was the lower than expected visual resolution on the visual display of both the basic and advanced FTDs. This presented problems for visual attitude recognition and visual navigation techniques. This was probably one of the main factors for the negative transfer of training to the aircraft.

The other significant problem is in the way that FTDs are used for educational efficiency and effectiveness. It is easy to stop an exercise or to position a student at the very beginning of a flight exercise and start the simulator. This allows a student to learn the particular flight manoeuvre rapidly. Unfortunately, the student is not in the real aeroplane and so does not readily learn the *extras* or airmanship aspects of the lesson. These include how to fly and navigate the aircraft to the training area, how to use the radio (what to say, what frequencies to monitor and at which position to change the frequency) and how to maintain a good lookout. In other words, elements can be taught separately in the FTD rather than holistically, as in the aircraft.

Further Research

Valuable lessons were learned in this trial that will be used in the design of the next stage. The next stage will include two studies. One study will continue the CCFT project. This will include a human factors study investigating the implementation of CCFT. The other study will investigate the training of technical flight skills in the FTD with the intention of replacing flight training time in the aircraft with flight training time in the simulator. These studies will operate in parallel. It is hoped that the simulator or FTD can be used to educated pilots in both crew beneficial behaviours and in technical flight skills so that less time will be spent training on the aircraft and more time spent training in the FTD or simulator. In both of these studies, scenario-based training methodology will be used to help rectify some of the problems associated with the learning of holistic elements of a flight lesson.

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