Running Head: RESEARCH PROPOSAL

"A comparative study of learning performance between pilots trained by current training method and pilots trained by the HCIPA Web-Based Training on the Boing 737 Flight Management Systems"

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Abstract

The proposed quantitative study will analyze the relationship between the pilot scores on tool certification and the instructional material being used. Pilots will be selected from a pilot training program in a recognized airline center. The pilots will be randomly assigned to either the treatment group or a control group. The treatment group will be trained on the use of the Flight Management System for Boing 737 using a Web-based training created using the HCIPA method, while the control group will be trained using the current training material. Two groups will be analyzed in order to identify the differences between the training material and students' assessment. It is hypothesized that the pilots trained using the HCIPA Web-based Training will report significant differences in the test assessment at the end of the training.

Introduction

Critical systems have been designed without considering human factors and human computer interaction principles. As mentioned by Klein, Wiggins, and Deal (2008), systems lack of support for users' cognitive requirements. Several papers have been writing about the poor design on cockpit automation, and the relationship between the pilot operator errors, and their response to the systems messages (Fennell et al., 2006; Sherry, Diez, Boehm-Davis, 2003; Sherry et al., 2002). A poor system design includes absence of visual cues, different semantic language in the system and the one used by operators, and several navigation pages to reach a function. Poor system design also leads to low proficiency in pilots' responses to specific tasks (Fennell et al., 2006). Although these problems have been identified and companies are aware of them, critical systems such as the cockpit automation cannot be changed in the mean time due to high costs on development, deployment, and potential safety constraints. Therefore, new pilots will be trained on these systems, and face the usability problems imposed by the design. In order to mitigate the usability problems in these systems, specific attention must be given to the training side. Improving and development strategies in training will provide users with better knowledge acquisition, and become experts on the system besides its low usability factors. Furthermore, current critical systems must be analyzed to generate all the task available through the systems, determine the operator actions, and identify the level of complexity in those operator actions. Identifying the tasks that are harder to learn, and require lot of memorization, is critical in order to provide better training, and minimize operator errors while facing execution of frequent and infrequent task through the system. Current training materials are not designed to reinforce the learnability of the tasks that are hard to remember and execute in the system. This

leads to poor performance on pilot score tests, and increase training hours needed to become a system proficiency (Sherry and Medina, 2008).

A new usability task analysis model, HCIPA, is being developed to address issues with usability in the aviation and space industries (Sherry and Medina, 2008). This method calculates the trials to mastery and probability to complete a task. With this information, instructional designers can create instructional materials that give special attention to the tasks with higher probability of failure, and provide more activities to the task that needs more trials to master. Furthermore, instructional designers can take a more objective decision on the best instructional delivery method to be used on the instruction.

Until now, the HCIPA method has been used only to analyze current systems design. However, as indicated on previous literature (Sherry, Diez, Boehm-Davis, 2006; Sherry and Medina, 2008) training time to competency is directly affected by the number of tasks with memorized action sequences that are not learned by prompting form external visual cues.

In order to provide a further description of the proposed research, this paper has four sections. The first section, Previous Work, provides an overview of previous research done in this area. The second section, Current Training Material, describes the characteristics of current training material used to train pilots on a Flight Management System. Next, the HCIPA method, provides an overview of how the task analysis is done on the system to estimate the trials to mastery and probability of failure. The last section, Method, describes the participants who will be on the study, the measures to be used to obtain the results, the procedure to carry out the research, and the data analysis to be used on the data obtained through the applied instrument.

Previous Work

Few studies have been founded regarding the analysis of different training materials and their impact in pilots performance. Rhind and Head (2004) examined 20 pilots who received either a traditional (explicit) training program or one that emphasized learning by experience (implicit). The purpose of the study was to analyze team performance and identify the effect of implicit training approach versus explicit training to to ab-initio pilots (none previous flight experience). Based on the result obtained through the experiment, authors concluded that implicit learning is a viable option to teach motor skills. The authors identified problems on the traditional teaching approach (explicit) and propose a learning by experience approach (implicit). The findings showed same or better performance of pilots trained using implicit method than those trained using the explicit method. However, the authors are not able to answer how much practice pilots need to be able to reach a point of asymptotic performance. The proposed research will carry out experiments where the numbers of practice trials are controlled. It goes beyond the problems on the traditional teaching material and modifies it to fulfill its deficiencies by identifying missing operator actions, providing visual images to each operator action, and providing number of trials to master the task. Another study performed by Nowinski, Holbrook, and Dismukes (2003) on the causes of avionics accident reveled that the common denominator on avionics accidents are due to lack of effective visual cues in the systems when performing infrequent tasks. The authors suggest creating visual cues as reminders, identifying infrequent tasks, and including the monitor step as a critical part of tasks. All these recommendations are part of the HCIPA method to be used on the proposed research.

Current Training Material

The current trained material used to teach the Flight Management System is a paper-based user guide that contains the description of the functionalities of the device. The operator actions needed to perform a specific task are listed on the manual, and some of them include screen shots. The material has not been designed to provide practices nor include the number of trials suggested to master the task. Furthermore, it does not provide visual aid to help students retain the operator actions that are hard to remember due to lack of visual cues on the device. The current material have been used through several years in the institution.

The HCIPA Method

The HCIPA stands for Human Computer Interaction Process Analysis (Sherry & Medina, 2008). The method has been designed to be used by systems and software developers to evaluate visual interfaces. In order to reduce the costs of this interaction, the HCIPA Method has been designed with three characteristics in mind:

- Easy to use: It does not require expert knowledge on Human Computer Interaction
- Simple: It does not involve knowledge acquisition of new languages
- Web-based Tool Support: It provides a web-based tool to document the HCIPA on the design

The benefits of using the HCIPA method are summarized as follow:

- Find usability problems on your prototype prior delivery to other teams member (HCI experts, software testing team, beta testers, users)
- Reduce re-development cycle time by fixing problems immediately
- Descriptions can be used on system training and documentation

The HCIPA method decomposes tasks into six sequential steps: Identify Task, Select Function, Access Function, Enter data for Function, Confirm and Save Data, and Monitor

Function. Based on Sherry and Medina (2008), the first step is to identify a task based on various external stimuli such as visual cues (menu item, error message), hearing cues (warning sounds), a request (e.g. checklist) or by remembering (e.g. recall from long-term memory). Once the user knows what to do, the next step is to decide the right function to accomplish the task, which is to select a function. The function may be the name of a screen, the label on a button, a prompt or any other characteristic that tells the user to initiate the task. The more accessible the function is to the user, the higher the probability is to accomplish the task. A set of operator actions are performed by a user in order to accomplish the task through the selected function. These operator actions are grouped under Access, Enter, Confirm and Save, and Monitor step:

- The Access Step encloses the operator actions needed to access the function on the device.
- The Enter Step encloses the operator actions needed to successfully execute the function.
- The Confirm and Save Step are all the operator actions needed to trigger the function.
- The Monitor Step encloses the operator actions needed to monitor any change on the system state after the function is triggered.

The HCIPA method provides a web-based tool that allows to perform and task analysis on a device. The tool automatically generates the probability to fail a task and the number of trials needed to master the task. It also generates a user guideline report on a pdf format. This report is the one that will be used during the proposed research. Additionally, the tool provides an option to simulate the tasks on a web-based environment.

Method

Participants

The participants in the proposed research are pilot students of a higher education school for aviation. They may have some flight experience but none Flight Management System

knowledge. Participants will be randomly assigned to either the control group or the experimental group. Participants will be volunteers willing to participate in the study.

Measures

A test will be applied to both groups after the training. The test will have five test tasks taken from the training material but will will differ on two aspects, following the idea used by Salden et al. (2006): (1) the amount of data that needs to be programmed into the FMS, and (2) the number of changes on the route will be increased. To obtain an objective scoring of performance, the same method used by Salden et. al (2006) will be applied during the proposed research. Four variables will be scored: (a) the given number of operator actions; (b) the number of correct operator actions; (c) the time on task, and (d) the time needed to process a change in flight route data. For all variables, a score of 1 will indicate a very low performance and a score of 5 a very high performance. The mean of this variables will be used to compare performance between groups.

Procedure

Both groups will receive the instructional material with 10 tasks to be learned on the Flight Management System. Participants will use the instructional material to learn the tasks, and will use a FMS simulator to practice the tasks. The control group will not have any required number of practices to continue with the next tasks. However, all participants in the experiment group will continue with the next learning task as soon as they have completed all the practices estimated to perform the task. Due to this situation, differences in training time will occur and it is expected that the experiment group takes more time than the control group to complete the learning process. As soon as all the participants of the experiment group have finished the

learning period, the test will be applied to both groups. It is expected that the experiment do not take more than a day. An instructor will be available to answer any questions in each group.

Data analysis

Descriptive statistics including one sample, t-test will be used to analyze the data. Calculation of means and standard deviations will be need to discover the differences between the groups.

References

Fennell, Karl., Sherry, Lance., Roberts, Ralph J. Jr., & Feary, Michael. Difficult Access: The Impact of Recall Steps on Flight Management System Errors (2006). *The International Journal of Aviation Psychology*, 16(2), 175-196. Retrieved on March 15th, 2008, from http://www.leaonline.com/doi/pdf/10.1207/s15327108ijap1602_4

Klein, Wiggins, Deal (2008). Cognitive Systems Engineering: The Hype and the Hope. *Computer*. 41(3), 95-97.

Nowinski, J.L., Holbrook, J.B., & Dismukes, R.K (2003). Human memory and cockpit operations: An ASRS study. In. R. Jensen (Ed.), *Proceedings of the 12th International Symposium on Aviation Psychology* (pp. 888-893). Dayton, ON: The Wright State University. Retrieved on March 15th, 2008, from http://human-factors.arc.nasa.gov/flightcognition/Publications/Nowinski_etal_ISAP03.pdf

Rhind, Daniel J. A., Head Tony (2004). The Benefits of Implicit Learning when Training Ab-Initio Pilots. *In International Journal of Applied Aviation Studies*, 4(2), 153-170. Retrieved on March 15th, 2008, from http://www.faa.gov.

Salden , Paas, van der Pal, van Merrienboer (2006). Dynamic Task Selection in Flight Management System Training. (Doctoral dissertation,Open University of the Netherlands, 2006). Retrieved May 10, 2008 from http://www.cs.cmu.edu/~rons/)

Sherry L., Diez, M., Boehm-Davis, D.A. Why the FMC/MCDU is hard to train and difficult to use? (2003). *Digital Avionics Systems Conference*. Retrieved on December 15th, 2005 from http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=1245819

Sherry L., Polson P., Feary M., & Palmer E. When Does the MCDU Interface Work Well?

Lessons Learned for the Design of New Flightdeck User-Interface (2002). *In proceedings of HCI Aero 2002*, (pp. 180-186). Retrieved on December 15th, 2005 from http://hsi.arc.nasa.gov/publications/20051025130453_MCDUWorksWell.pdf

Sherry, L., Medina, M. Automated Tool for Task Analysis of NextGen Automation (2008). *Integrated Communications Navigation and Surveillance (ICNS) Conference*, Maryland, USA.