Comparing Helicopter Interfaces with CogTool

Jeremy Ludwig (ludwig@stottlerhenke.com)
Stottler Henke, 951 Mariner's Island Blvd
San Mateo, CA 94404

Abstract

The Common Cockpit program for the Navy's new helicopters specifies a single cockpit interface for diverse helicopters. This single interface supports different helicopters through the use of programmable keysets. One significant difference between two particular keysets, as currently implemented in the MH-60S (Sierra) and MH-60R (Romeo), is the manner of alphanumeric data entry. The Sierra offers a full set of 26+ keys, one letter per key, while the Romeo offers a condensed, cell-phone style where a single key contains three letters and a number. Cognitive models are created of these two different methods of user interaction, making use of the simulation and training software OMIA and the CogTool modeling system. Results of the two different interfaces are compared based on alphabetic data entry tasks currently used in Sierra training. The implications of these results are discussed when using similar tools in designing user interfaces.

Introduction

The Common Cockpit program for the Navy's new MH-60R and MH-60S helicopters specifies a single cockpit interface for these helicopters. The MH-60S, "Sierra", built for transportation and SAR missions, and the MH-60R, "Romeo", built for undersea warfare. A single interface supports these two different types of helicopters through the use of programmable keysets. The Sierra offers a full set of 26+ keys for alphabetic entry, one letter per key, while the Romeo offers a condensed, cell-phone style where a single key contains three letters and a number.

This abstract describes how cognitive models are created of these two user interfaces in order to assess the impact of the different methods of interaction on the amount of time it takes to enter alphabetic information. These models make use of the simulation and training software OMIA (Ludwig & Jackson, 2001) and are built with the CogTool (John et al., 2004) modeling system. This paper seeks to answer the following design question: should alphabetic data entry in the newer, Romeo, interface be faster than in the Sierra interface?

OMIA Common Cockpit Training Tool

The OMIA common cockpit training tool is a partial task trainer for the MH-60S (Sierra) and MH-60R (Romeo) helicopters. OMIA provides a simplified yet realistic desktop-based version of the helicopter software and hardware.

In the Sierra, alphabetic entry is accomplished through a set of programmable keys where each key has a single letter. To enter an alphabetic character, the corresponding programmable key is pressed. Alphabetic input in the Romeo is accomplished by using keys that contain more than one letter, similar to a cell phone. For example, the first key is ABC1. Pressing this key once enters an A, twice a B, three times, C, four times 1, and five times A. The next input spot will be selected automatically when the user either selects a different key or after a brief pause where the same key is not repeatedly pressed.

CogTool Modeling System

The CogTool modeling system (John et al., 2004) aims to make the generation of cognitive models much easier. Task interfaces are created using the Dreamweaver environment, a WYSIWYG html development tool that can be augmented with specialized CogTool components.

Creating simulated interfaces with this tool is fairly simple (Esch et al., 2005). For this paper, the following method was used: images of the interface are embedded in an html web page and *hot spots* are drawn on top of the diagram. These hot spots record when a user clicks or rolls over them and allow transitions to different web pages after the given action. This allows the system to model interactive interfaces.

Once the interface is created, the task knowledge is constructed simply by demonstrating the task on the interface. Users perform the task on the html pages and the Behavior Recorder portion of CogTool captures these actions. These actions are eventually compiled into an ACT-R based model.

The final step in the modeling process is to execute the task on the simulated interface. The Behavior Recorder interacts with the web pages to perform the task, based on the ACT-R model generated in the previous step. During model execution, the Behavior Recorder tracks how much time it takes for the architecture to complete the model. This return value, the amount of time, is the architectures estimate of how long it would take an expert human user to complete the task.

Methods

The main task is to enter a number of alphabetic strings. Nine data entry tasks were taken from the MH-60S training manual. The tasks are the same for both models, even though they are carried out differently. For example, in the Sierra typing "ALPHA" requires the following key presses: 1, A, L, P, H, A, ENT. In the Romeo, the sequence is: 1, A, J, J, J, P, G, G, A, ENT. All of the data entry tasks involve entering a preparation key, a short word, and finally the enter key.

As mentioned earlier, web pages are used to describe the simulated helicopter interfaces for CogTool. A number of button hot spots, one for each programmable and fixed key, are added to a keypad image in Macromedia. After the basic interface is created, each task is demonstrated and captured by the Behavior Recorder, simulating actual hand movements.

Initially models contained a *think* action, taking 1.2 seconds, before every action. For example, the following sequence presses "1":

(think)
(look-at "1")
(press-button "1").

With bracketing in mind (Kieras & Meyer, 2000), models are created with a *think* operator before every motion (upper bound) and with all *think* operators removed (lower bound). A refined model is also created for the Romeo where *think* operators are removed from the upper bound model after pressing the same button more than once.

Results

The CogTool Behavior Recorder was used to determine the time it takes for each of the five models to perform all of the data entry tasks as described previously. The results are summarized in Table 1. The Sierra and Romeo models include all of the think operators. These models are exactly those generated by the behavior recorder. The Sierra-No Think and Romeo-No Think models are the same tasks with all of the think operators removed. The Romeo-Partial model is the third Romeo model, where all of the think operators have been removed for the re-pressing of a key.

Table 1: Average task completion in seconds

Sierra	14.0
Sierra-No Think	4.3
Romeo	23.2
Romeo-No Think	5.0
Romeo-Partial	14.4

It is common practice to include observed data (that gathered from actual user trials) with the model results. This allows comparisons to be made about both the qualitative and quantitative fit of the predicted (model-generated) data as compared to the observed. However, in this particular case no user trials have been run so there is no observed data to report at this time.

Discussion

The goal of this modeling effort is to compare two different methods of human-computer interaction, quickly and efficiently, and determine which of the two will likely be better in an operational setting. Using the modeling techniques described in this paper, it would have been possible to develop these models during the interface design stage based on image mockups.

Looking at the results found in this paper, the initial Romeo model takes about twice as long to enter data as the original Sierra model. However, the Romeo-Partial model based on removing think operators for repetitive keys is a fairly close match to the Sierra model and is intuitively a better model of interaction in the Romeo. Because the initial Romeo model seems so unlikely, it was discarded as a choice for the upper bound on the actual time for user entry. A lower bound is formed by the models that have all think operators removed. This lower bound assumes that the user still has to look at each key before pressing it, so operators using touch typing might actually be able to do it more quickly. Notwithstanding, this seems a reasonable lower bound for most users. Based on the generated data, and the choice in upper and lower bounds, it appears that entering information into these two interfaces will take roughly the same time either way. There is no clear winner or loser that can be determined based on these results.

The results found in this paper demonstrate that even while using a fairly simple modeling methodology and simulating short data entry tasks, creating a "good" model is still somewhat of an art. While the Romeo-Partial model would be fairly obvious to most modelers, it requires manipulation by hand to realize. Further, the times taken by the initial models, with all of the think operators, would obviously be too large to anyone with even casual experience actually using the interface.

References

Esch, S., Centgraf, P., Prevas, K., & Eiser. (2005). *A.CogTool User Guide version 0.9.1.*, from http://www-2.cs.cmu.edu/~bej/cogtool/publications.html

John, B., Prevas, K., Salvucci, D. D., & Koedinger, K. (2004). Predictive human performance modeling made easy. In *Human Factors in Computing Systems: CHI 2004 Conference Proceedings*. New York: ACM Press.

Kieras, D. E., & Meyer, D. E. (2000). The role of cognitive task analysis in the application of predictive models of human performance. In J. M. Schraagen & S. F. Chipman (Eds.), *Cognitive Task Analysis*. Mahwah, NJ: Erlbaum.

Ludwig, J., & Jackson, H. (2001). *Intelligent tutoring and simulation system for a common cockpit helicopter.* Paper presented at the Interservice / Industry Training, Simulation, and Education Conference '01, Orlando, FL.