Image Cover Sheet

CLASSIFICATION	SYSTEM NUMBER 147570
UNCLASSIFIED	

TITLE

USE OF AN AUTOMATIC TRACKER AS A FUNCTION OF ITS RELIABILITY

AN: 94-06698

System Number:

Patron Number:

Requester:

Notes:

DSIS Use only:

Deliver to: JR

VOL. 4: ERGONOMICS AND DESIGN ■ IEA '94 ■

USE OF AN AUTOMATIC TRACKER AS A FUNCTION OF ITS RELIABILITY

Sharon M. McFadden, Barry L. Giesbrecht and Anne L. Israeli
Defence and Civil Institute of Environmental Medicine
P.O. Box 2000, North York, Ontario, Canada, M3M 3B9

ABSTRACT

The present study examined the use and usefulness of an automated tracker as a function of its reliability. Both increased as reliability increased. However, some subjects tried to make extensive use of the automated tracker even when its reliability was low. When the automated tracker was reliable, there was evidence that subjects failed to recognize errors made by it even with feedback and sufficient time to correct the errors.

INTRODUCTION

Automated controllers and decision aids are becoming an integral part of many complex computer-based systems. They are implemented with the aim of reducing human error and workload and improving system performance. However, it is not clear to what extent these goals are met, either because of failure to consider human capabilities and task requirements, or because the human does not use the aids. For example, research has shown that the use of an automated controller varies as a function of the operator's trust in it (Lee and Moray, 1991). Unless the controller is perceived as reliable, an operator may not use it to its full potential. Even when an aid is perceived as reliable, users may still use it suboptimally in order to maintain some feeling of control over the system (Morris, Rouse and Ward, 1988, Weisgerber and Savage, 1990).

The current study examined the issue of system reliability, operator use, and system performance in the context of a simulated target tracking task in which an user must monitor and update the position of targets over time. Target position is updated by comparing the location of each target on a display with the strength and location of new signals that are presented at regular time intervals and associating a signal to each target. The source of the signals could be either relevant targets (ships) or non-targets (e.g. marine life). The operator can track the targets manually or assign some or all of them to an automatic tracker (AT) which tried to match each target that it is responsible for with a signal.

METHOD

Eight subjects, five males and three females between the ages of 19 and 41 years, participated in the experiment. All had normal or corrected to normal vision based on self report.

The Automatic Tracking System (ATS), a software system developed for studying the use of an automatic aid, was used to carry out the experiment. It was run on a Macintosh IIci computer. The display for the ATS was presented on a 13 in. RGB monitor. As shown in Figure 1, it consists of a tracking display (circle), signal table, a set of function buttons, two clocks that show the time left before a new set of signals appears and before the run is over, and an optional feedback window. Subject communication with the task is by means of a cursor controlled mouse. By clicking on the word "manual", the user can replace the manual signal table and feedback window with equivalent versions that show the signals being monitored by the AT and its performance.

The task was to add new targets or update the position of existing targets each time that new data about the location and strength of possible targets (signals) was provided (each refresh). For each target marker, the subject searched for a signal that had a similar radius (r) and bearing (B). Position was updated by clicking on the signal table entry, the marker, and then on the "associate" button. Target markers could also be disassociated from a signal, removed from the display, and assigned to or deassigned from the AT. If there were fewer than the expected number of target markers (8) on the display, the subject search the remaining signals for new targets and added them. At the beginning of each refresh, the AT scanned the list of signals and tried to update the position of the targets it was responsible for. All of the signals that it did not associate with target markers were displayed on the manual signal table. Feedback about the performance of the subject and AT was provided at the start of each refresh.

Performance was measured on three different scenarios under four different levels of AT reliability, nil, low, medium, and high, that had been empirically determined in a pilot study. Reliability was varied by changing the size of the area around the current position of the target marker that the AT searched for a signal that could represent the target's new position. Subjects completed three scenarios under each condition. A scenario was composed of a set of targets that traced out specified paths (e.g. circle, line, zigzag). If a target's path took it off the screen, a new target was initiated. Subjects carried out four training sessions, of four to five runs each, during which they practiced carrying out the task manually and with a high reliability AT. The number of targets increased from four, with a refresh every 30 seconds, to 8 with a refresh every 40 seconds. During each test session, they updated the position of eight targets every 40 seconds, over a 20 minute period. Each test day, subjects carried out three runs, each at a different AT reliability and using a different scenario. A different order of the conditions was used for each subject.

RESULTS

Performance measures included targets and non-targets tracked (added or associated), missed, and lost each refresh period by the subject, AT, and system (human plus AT), use of the AT by the subject (assigns and deassigns), and time required to handle the signals. System measures were taken at the end of each refresh and thus reflected the total number of signals handled successfully. For example, if the AT generated a false alarm (associated a non-target to a target marker), but the subject caught it, that false alarm would not be included in the estimate of system false alarms for that period.

Most of the subjects found the task difficult when the AT was not available. Without its help, targets were tracked correctly 50% to 86% of the time across the eight subjects. With even a low reliability AT, performance improved significantly. Across the four conditions, 65, 79, 87, and 90% of the targets were tracked on average. As performance increased, the time required to handle all the targets decreased from 34 seconds per refresh without the AT to 18 seconds under the high reliability condition. Errors due to missed or lost targets decreased from around 15% to 5% and 1% respectively as AT reliability increased. Misassociated targets also decreased from 5% to 1% in two scenarios. However in the third, they increased up to 7%. In that scenario, the paths of two targets crossed. Under the high reliability condition, the AT would confuse them. If the subject failed to notice this event, the misassociation continued until both targets left the screen or the AT lost them.

The previous measures reflect system performance only if the false alarm rate is low and consistent across conditions. 100% could be achieved by adding all the signals (target and non-target) on each refresh. The system false alarm rate averaged around 5% in the high reliability condition and 3% in the remaining conditions with the extra 2% due to AT false alarms that subjects did not see.

All of the subjects used the AT to some extent when it was available. The percentage of total targets assigned to and tracked by the AT averaged 6, 57, 75, and 85% across the four conditions. If 100% of the targets had been assigned to the AT, the percentage of targets tracked by the AT on average would have been 52, 73, and 83% in the low, medium, and high reliability conditions respectively. A comparison of the two sets of figures suggests that the subjects were using the AT relatively efficiently. However, there were considerable individual differences. Four subjects consistently assigned targets that the AT could not track while the other four appeared to be relatively conservative in their use of the AT. The percentage of targets assigned to and tracked by the AT averaged 38, 53, and 73% across the three levels of reliability for the conservative subjects and 77, 90, and 94% for the remaining subjects.

DISCUSSION

As stated in the introduction, studies on the use of automated controllers and decision aids frequently find that people do not use them unless they perceive them as reliable. Even then they often continue to rely at least partially on their own ability. In this study, all of the subjects made at least some use of the automatic tracker under all levels of reliability. One possible reason was task difficulty. Using the AT clearly reduced workload and improved system performance. Lee and Moray (1991) found that people used an automated controller when their trust in it exceeded their trust in their own performance. While the subjects could track most of the targets better than the AT, it was difficult for them to track all eight in the time available. Since the reliability of the

AT varied from run to run, the subject did not know how well it would work on a given run. Thus, it was probably worth trying to use it on each run. An examination of AT use over the duration of a run showed that conservative subjects initially assigned a large number of targets and then shifted to handling them manually if the AT was not reliable. However, the rest continued to assign targets that the AT could not track effectively. This behaviour increased their workload because they had to deassign, associate, and reassign targets that the AT lost and thus reflects an inefficient use of the AT.

Another possible reason for the extensive use of the AT was that subjects never lost overall control when they assigned targets to the AT. Rouse and Morris (1986) concluded that users are more likely to use an automated aid if they have some discretion in using it and if they can intervene when necessary. Subjects could monitor the AT's decisions and change them if they wished.

The results for the high reliability AT were consistent with another observation of Rouse and Morris (1986) that, when an automated system is reliable, users have trouble remaining vigilant and detecting problems. On average, subjects had 20 seconds to spare on each refresh in the high reliability condition. However, it appears that they did not use this time to check for AT errors although feedback on the AT's performance was available. There was a significant increase in the percentage of false alarms in that condition as compared to the low reliability condition. This result would suggest that there might be some advantage to using a less reliable AT that produced more lost targets which the subjects did notice and fewer false alarms and misassociations which they often missed.

REFERENCES

Lee, J. and Moray, N. 1989, Trust, self-confidence and supervisory control in a process control simulation, Proceedings of the IEEE International Conference on Systems Man and Cybernetics, 291-295.

Morris, N. M., Rouse, W. B., and Ward, S. L. 1988, Studies of dynamic task allocation in an aerial search environment, IEEE Transactions on System, Man, and Cybernetics, 18, 376-388.

Rouse, W. B. and Morris, N. M. 1986, Understanding and enhancing user acceptance of computer technology, IEEE Transactions on System, Man, and Cybernetics, 16, 965-973.

Weisgerber, S. A. and Savage, S. F. 1990, Operator ship classification using an Automatic Target Recognition (ATR) system in conjunction with Forward-Looking Infrared (FLIR) imagery, NWC TP 7101, Naval Weapons Center, China Lake, CA.

(

F

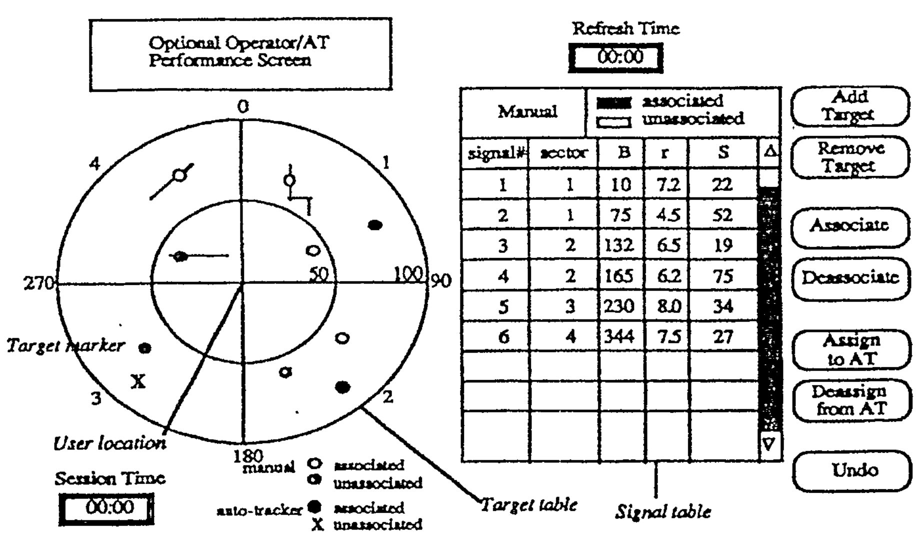

Figure 1: A schematic of the display for the Automatic Tracking System (ATS).

Proceedings of the 12th Triennial Congress of the International Ergonomics Association

Comptes rendus du 12e Congrès triennal de l'Association internationale d'ergonomie

VOLUME 4

Ergonomics and Design

Ergonomie et design

IEA '94

TORONTO, CANADA

August 15 - 19, 1994 • du 15 au 19 août 1994

ISBN 0-9698544-3-9