Training People to Use Automation: Strategies and Methods

John S. BARNETT
U.S. Army Research Institute for the
Behavioral and Social Sciences
Orlando, FL 32826 USA

ABSTRACT

Automation is being introduced into the workplace more and more frequently, and more and more people are learning to use automated systems. However, many people tend to exhibit patterns of behavior towards automation which influences how they use it, or if they use it at all. Often, these behavior patterns can either negate the advantages of automation, or allow automation to lead people into precarious situations. This paper discusses some of these common behavior patterns and how training may help people avoid their negative consequences. It also includes a suggested automation training strategy to help training developers design training programs for automated systems that takes user attitudes towards automation into account.

Keywords: Automation Training, Attitudes Towards Computers, Disuse, Overuse, Training Strategies

INTRODUCTION

The increasing use of technology in the work force has introduced automation into a number of areas. Consequently, many people must learn to work with automated systems. Although automation promises significant benefits to productivity, the integration of automation into work spaces has brought with it its own set of problems. Depending upon the function of the automation, these problems can range from minor annoyances to potentially dangerous situations.

The promise of automation is that it performs tasks for people and makes their jobs easier. However, the reality is that although automation often allows people to perform tasks that would not be possible without it, the cost is that the automation is often difficult to use. Often this cost is not considered when decisions are made about whether to automate tasks. Many people assume that automating jobs makes them easier, but experience in the field of aviation shows that automation sometimes complicates things in unexpected ways [5]. In fact, automation may not even reduce workload. Research suggests that automation does not reduce workload as much as change the nature of the work from performing tasks to monitoring the automation [15], [14], [6].

Because of the increased complexity automation brings to the job, it is important have a carefully designed training program to train people to employ the automation and help integrate automation into the work environment. This paper presents some guidelines for training people to work with automation. The guidelines are based on what we know about how people interact with automated systems. A considerable body of research in this area has accumulated over the past several decades. Much of this research can be applied to help guide automation users through the process of learning to use automation effectively and safely.

The first section of this paper provides some background on automation research relevant to automation training. Following that, the next section shows how this knowledge can be used to guide users through the learning process to produce skilled automation experts.

BACKGROUND

Attitudes and Behaviors Towards Automation

People's attitudes and behaviors towards automation can influence their motivation to learn about and use automated systems [10]. Preliminary research suggests that attitudes and behaviors towards automation may be common among different work environments. Barnett and Meliza [3] found that many concerns (over 60%) expressed by soldiers about using automated command and control systems were similar to those expressed by commercial aviators about using automated flight control systems. This is important because if people from such different areas have similar attitudes towards automation, it suggests there may be a common model of how people approach automation, and a common training strategy may be useful regardless of the type of automated system or work environment.

Patterns of Behavior

Research and theory suggests there may be several common behavior patterns people exhibit towards automation, particularly as automation is introduced into their work environments. Parasuraman and Riley [11] described patterns of behavior towards automation as use, disuse, and misuse respectively. "Use" is when automation is employed appropriately to perform tasks, "disuse" is when people do not employ automation when it would be appropriate to do so, and "misuse" (also called overuse or over-reliance) is when people use automation when non-automated means would be better and safer.

For example, although some people have no objections to using automation, others are not motivated to employ it and may instead avoid using automation where possible. These "disusers" may have little confidence in the automation or may believe learning to use automation requires too much effort.

In situations where people have considerable experience performing tasks without automation, learning to perform the same tasks using automation requires additional effort on their part. In addition, they may feel confident that they can perform the task manually, but less confident that the automation can do the job as well.

On the other hand, people sometimes employ automation too much; they tend to over-rely on features of the automation, which may sometimes lead to trouble. Misuse (also known as overuse) of automation can sometimes lead to complacency [9] and potentially dangerous situations. For example, Sarter and Woods [12] found when pilots in a simulator were erroneously notified of an engine malfunction by an "automated" system, they reacted to the automated alert without question; they shut-down the engine even though the non-automated instruments showed it was working correctly. They believed the automated system without verifying its accuracy, a phenomenon called "automation bias." As this example suggests, over-reliance on automation can be particularly precarious when the automation doesn't perform as expected, either through malfunction or improper operation.

In addition to use, disuse, and misuse, Barnett [1] added limited use, which is described as the willingness to employ only a few features of automation, but not take advantage of the full range of available automated tools.

Some of these behavior patterns (disuse, limited use, and misuse or over-reliance) can have an impact on the effectiveness of the human-automation team. People who avoid automation (disuse) or only use it in a limited way (limited use) are not taking advantage of its full potential. Automating systems is often expensive, and when the automation is not used to its full potential, the investment in automation is wasted. On the other hand, people who over-rely on automation may have considerable difficulties when the automation fails to perform as expected [13], [8].

AUTOMATION TRAINING PITFALLS

The training people receive on automated systems is frequently minimal. Training often focuses on descriptions of controls and displays, but not how the automation is best employed [4]. Typically, training methods can vary from formal training, to apprenticeship type training or on-the-job training (OJT), to unstructured discovery learning [1]. Formal training is often the best, but is normally expensive. Apprenticeship or OJT relies on users with more experience training novices. Unless the experienced users are trained instructors, they often have a difficult time presenting information to novices in a manner that novices can understand. Sometimes there is no training program and novices are expected to learn on their own (discovery learning). Discovery learning can be frustrating and time consuming.

Unfortunately, the less-formal training methods can sometimes reinforce the negative aspects of the above behavior patterns. For example, people who would rather not use automation (disuse) can be reinforced in their belief when the automation works poorly or has problems. Such problems tend to confirm the users decision to avoid using automation. Conversely, people who over-rely on automation may be encouraged to become complacent if they are trained with automated systems which always work and they never experience malfunctions of the system.

AN AUTOMATION TRAINING STRATEGY

A carefully considered training strategy may reinforce more positive attitudes and behaviors towards using automation. For example, if disusers are introduced to automated tools which significantly reduce their workload or solve a difficult problem, they may be encouraged to use automation more. This idea is illustrated by an account written by a military commander about how he learned to use an automated command and control (C2) system. The commander reported that initially he did not use the system because he received only rudimentary training in its use and he was not confident in his ability to employ it. Instead, he relied on conventional paper maps to direct his unit. However, when faced with a situation where his unit traveled beyond his map coverage, he turned to the automated system which had full map coverage of the area. In this case, the automation allowed his unit to continue to maneuver, which would have been difficult to impossible without the automated C2 system. This experience motivated the commander to use the automation available to him [7].

A strategy for training people to work with automation should focus on helping people avoid the negative behavior patterns associated with automation. Such a strategy might include presenting training in such as way as to affect people's attitudes and behaviors towards automation as well as teach them to operate the automated system. The training might be presented in phases, with each phase designed to encourage positive attitudes towards automation and discourage or prevent less positive behavior patterns. The initial phase should focus on motivating people to utilize the automated system and instill confidence in it. The next phase should encourage them to build on what they have learned and try out all of the features of the automation. Once the users have developed some confidence in the automation and their ability to employ it, training should present potential malfunctions of the automation to ensure the user's confidence remains realistic. Finally, the latter states of training, including continuation or sustainment training, should encourage users to maintain their level of skill. The following presents these phases in more detail and provides suggestions about how they might be presented.

Phase 1: Motivate and Instill Confidence

This phase of training is designed to encourage people to use automation and as a counter to disuse. The initial training should motivate users to employ automation as well as instill confidence in the automation and in the user's own abilities to operate the automation. One way to motivate new users is to show them how automation can help them. If possible, initial training should include procedures that automate difficult or time consuming tasks. Learning to use automation often requires additional effort [1], and new users should be shown that the advantages of using the automation is worth the effort.

Also, at this stage the training focus should be on the automation's utility and not on it's problems or shortfalls. Most automated systems have problems which users should be trained to deal with, but such training should come later. Some automated systems have training modes or simulators which allow parts of the system to be failed by instructors for training purposes. Instructors should definitely *avoid* presenting new users with failures at this stage of training. New users who ask about system reliability or what they should do when the system malfunctions should be told that recovery from automation failures will be covered in a later section. Instructors should not present an unrealistic picture of the automation's reliability, but instead should tell new users that dealing with failures and malfunctions will be taught once the basics of automation operation are mastered.

Phase II: Develop Skills
Once novice users have learned to employ a few automation functions, instructors should encourage them to expand their automation skill set. As mentioned, some people learn a few automation skills but resist learning a full range of functions. This phase of training should reinforce the functions they know, while introducing them to new tools and techniques.

One theory of why people resist learning new techniques is that they believe it is either too much effort or they do not understand the value of being able to employ the new techniques, or a combination of both. By guiding users through new procedures, instructors address both of these factors. Users who are led through new applications learn the value of the applications and may see the utility of investing the further effort to master the techniques, particularly since they have invested some effort in learning the new procedures already.

Phase III: Discourage Overconfidence and Overuse
When users have developed a range of automation skills and come to depend on automation, it is time for instructors to change directions and introduce them to the limitations of the automation. It is somewhat ironic that after spending time bolstering the user's trust in the automation, it is necessary to now alter their confidence level. However, this strategy may reduce over-reliance on automation.

There is some question about how much training alone can affect user's confidence in automation [2], but certain evidence suggests that user's interaction with automated systems does have an effect on their confidence level. Therefore, where possible, instructors should use "hands-on" training using the automated system itself or a simulation of the system. During this hands-on training, instructors can introduce common failures and problems which may help users develop an appropriate level of confidence in the system that is neither too low or too high.

As well as affecting user's reliance on that automation, it's also necessary to teach users how to deal with automation failures. Research indicates that recovering from automation failures is often difficult [13], [12]. Introducing common errors and problems during training, along with their solutions, helps users learn how to deal with them when such situations arise.

Phase IV: Maintain High Level of Expertise
Finally, as users become more expert with the automation, instruction should focus on maintaining their level of skill. Any follow-on training should focus on little-used or easily forgotten skills. Of course, whenever the automation or software is updated, the new procedures should be trained and integrated into the user's skill set as well.

SUMMARY

Helping integrate automation into work environments requires a well designed training program. Training must not only teach new users to operate the automation, but also help them develop an appropriate level of confidence in the automated system, as well as in their ability to operate it. Training should also help users avoid common behavior patterns which hinder them from exploiting the advantages of automation. They must develop the skills necessary use automation wisely and revert to non-automated means when automated systems have problems. Continuation training can help expert users maintain their level of skill. A carefully developed training strategy may help people make the most of automation in their work places.

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