Breakdowns in Human-Automation Coordination Can Create Automation Surprises

Across a number of industries, improved automation has increased both the precision and efficiency of operations. However, automation has also introduced a new set of interrelated problems for those who use it. Whether it is a pilot flying a plane or an operator controlling a chemical process, new types of human-automation problems are happening and unfortunately, in some cases, with disastrous consequences.

Fortunately, research is being conducted to help identify and overcome human-automation interaction problems. One recent study, (Starter, N., Woods, D. (1997). Team Play with a Powerful and Independent Agent: Operational Experience and Automation Surprises on the Airbus A-320, Human Factors, 39, 553-569), attempted to define commonalities of mode awareness problems and automation surprises across different types of highly automated airplanes. Although there is little resemblance between an airplane and a chemical processing plant, there are a number of similarities between the new automation used in their control. As it turns out, pilots and chemical plant operators appear to be experiencing many of the same problems with the new automation.

In the study, researchers interviewed pilots from the Airbus A-320 to examine mode awareness and other reoccurring automation problems. Mode awareness problems occur when pilots lose track of the current and future status and behavior of the automation. There were a number of findings in the study, including three reoccurring types of problems that pilots experience: (1) when the automation did not take an action that was expected, (2) when the automation made an action that was unexpected, and (3) when the automation carried out a task in an unexpected manner. In each of these three problem types, the pilots had some expectation of the functioning of the automation and the automation behaved in a way that violated the expectation.

The study’s authors cite a lack of at vat vat vat vat vat vat vor for many of the problems. The lack of mode awareness leads to automation surprises that happen when the automation’s behavior violates the operator’s expectations (what is it doing and why is it doing that?). Automation surprises usually begin as miscommunications and misassessments between the pilots and the automation. Previous research has found several items that contribute to the gaps between the operator’s expectations and the system’s behavior, including: (1) operator’s poor mental models of the system, (2) low system observability (due to deficient display and alarm system designs), and (3) highly dynamic, non routine operations. observable

Another important finding in the study was a marked difference in the pilots’ instrument monitoring strategies and scanning patterns. For those with conventional systems (with little automation), their visual scans were highly practiced and fairly effortless. In contrast, the scan patterns of those with highly automated systems were found to be reflective and requiring higher mental effort as the pilots had to determine where to look next and for what type of information. Contrary to what many might think, the higher autonomy of the automated systems does not automatically make the jobs easier and reduce workload. Although the operator of the system may make fewer manual adjustments, the automation has made staying abreast of the operations more complex and difficult. Instead of just monitoring some basic set of instruments to gauge how the plane is performing, now the pilots must monitor the automation making the adjustments and infer how the automation is making the plane perform. The pilots’ role has changed from direct hands-on flying to monitoring and managing the automation doing the flying.

Similar to the pilots’ experiences, operators in the process control industry are also having problems tracking the status of their new advanced automated control systems. Beville has listened to countless operators lament that they often do not understand how the advanced control is adjusting their processes. Operators have also said that they have lost much of their basic skill of adjusting the instruments. In addition, operators have reported missing
events because their scan patterns changed. Similar to the pilots, the chemical plant operator’s role is changing from direct hands on operation to more of a system manager and director, and their informational needs have changed as well. Unfortunately, like the pilots, the operators frequently are not provided the tools they need to effectively take on this new role.

The researchers in the study suggest that better feedback mechanisms need to be developed to overcome the automation surprises. Automation information needs to be better presented to the users through enhanced display and alarm systems. The displays need to facilitate tracking and prediction of the automation’s past, present, and future behavior. Contrary to many display designers’ past practices, in which the automation was made transparent to the users, displays need to clearly demarcate those instruments that are under higher level automatic control and their mode of operation.

There is no doubt that automation can make a process more efficient. However, there is also a growing body of evidence that, because of poor interface designs, automation has added complexity to the jobs of those who use it. The first step in overcoming this problem is an understanding of how the users and automated systems function as a team. When that is understood, proper interfaces, aids, and training programs can be developed.