How to sharpen your automated tools

by Dr Kim Cardosi

Save fuel and the environment with fewer emissions! Fly more flexible routes! Get better altitudes! Programmes that claim to make flying more efficient have several things in common – new tasks for pilots, new flight deck displays, automated decision support tools, changes to ground automation and to displays for air traffic control (ATC) and changes to air traffic procedures...

Dr. Kim Cardosi is the Principal Technical Advisor in Aviation Human Factors at the Department of Transportation's Volpe Center in the United States. She earned a Ph.D. in Experimental Psychology from Brown University in 1985 and a private pilot's certificate in 1989. Since 1985, she has been working in flight deck and air traffic control human factors at the Volpe Center. Research areas include: controller-pilot voice and datalink communications, system performance metrics, runway safety, and air-ground integration of NextGen applications.

Cost-benefit assessments determine the initial investment for air carriers and estimate the magnitude of the return on their investment. Safety assessments identify potential hazards and determine if the inherent risks of aircraft flying closer together are sufficiently mitigated. Mechanical components and software are tested to ensure that they perform as intended. But not even in the small print is the underlying assumption that the advertised benefits can only be realised if the equipment is user-friendly, the automation is 'trustworthy' and pilots and/or controllers are motivated to use it. This means that the benefits to the front-end users—pilots and controllers—have to outweigh the costs of additional workload.

One piece of automation which is beginning to arrive in the flight deck that should bring advantages is Automatic Dependent Surveillance – Broadcast (ADS-B)[31] which displays appropriately-equipped traffic[32] in the vicinity of an appropriately-equipped aeroplane[33] to the pilots. Automation like this sound intuitively like a good idea, but it has to be implemented effectively. This means getting the Human Factors of the design right so that it is straightforward for the pilot to use. What follows is based on some initial experience with ADS-B –based flight deck traffic displays in the USA and its use by pilots. One of the key lessons already learned is that just applying Human Factors design guidelines for new automation is never going to suffice – we need to do this in conjunction with pilots in order to optimise its use. Some of this is done before the system reaches the flight deck, but it's often afterwards, in the first weeks or months of implementation, that some of the real learning takes place, as operational experience is gained. So, how do we get this crucial feedback from pilots? I'll come back to this point at the end. But first, a bit more on getting it as right as we can from the start.

There is a wealth of human factors guidance for good equipment design as it relates to displays and controls. But assuming we have a well-designed system with an intuitive display, easy to operate controls and an operating procedure with no mental gymnastics required, there are several aspects that still need to be addressed on the checklist for success.

So, how do I use it?

Training is one of the tools needed for an automated system to succeed. Without proper training, there is no return on investment in automated tools. Training should involve much more than learning a series of opera-

31- See http://www.skybrary.aero/index.php/Automatic_Dependent_Surveillance_Broadcast_(ADS-B)
32- Aeroplanes which are equipped with ADS-B In
33- Aeroplanes which are equipped with ADS-B Out

tional steps. Before introducing the mechanics of an operation, the benefits from a system perspective should be explained and ideally work down to 'what's in it for me?' This includes not only the current equipment and procedures, but also scheduled updates. An understanding of the big picture that includes what occurs on the other side of the microphone is an important part of training that is often overlooked, but becoming increasingly important.

What you see is what you get. However…

Training for both pilots and controllers on ADS-B applications should include the capabilities and limitations of the technology. ADS-B In equipage allows flight crews to have more accurate real-time information than controllers – but only with respect to the distance between their aircraft and other aircraft equipped with ADS-B Out. Controllers have the advantage of the more complete picture. Limitations to the flight crews' view are namely:

- ADS-B In systems can't detect aircraft without ADS-B equipment (ADS-B Out).
- ADS-B In systems have range limitations (150-250 nm), so traffic beyond this range is not likely to be displayed.

What you see depends on which window you're looking through…
Flight deck displays of traffic may have different pages or views. It's important for pilots to understand which views/pages (if any) interact with information in the Flight Management Computer (FMC) and what actions can be taken without affecting information in the FMC. Training should include the intended use of each page or view and best practices for use of the different features, including an explanation of what traffic is displayed/excluded in each view. For example, if only ADS-B traffic is displayed, it may surprise pilots when some nearby traffic is not on the display!

Lost in Translation?

Flight deck displays of traffic can display the call signs of ADS-B Out aircraft. In order for pilots to call the other aircraft or to refer to the other aircraft in voiced communications with air traffic, pilots will need to 'translate' the displayed aircraft call sign. Some call signs are likely to be familiar to pilots (such as 'UAL' for United and 'AAL' for American). Others, such as 'AZA' for Alitalia, 'DLH' for Lufthansa, 'AAR' for Asiana, and 'QFA' for Qantas are less familiar in the US, for example. It would be helpful for pilots to have a way to match the three letter identifier in the aircraft call sign to the call sign prefix used in voiced communications. This could be as simple as a list of carriers that they are likely to encounter during their flight.

How to sharpen your automated tools (cont'd)

What's in it for me?

It's important for pilots and controllers to know that the value of ADS-B displays on the flight deck extends beyond any individual procedure. For example, pilots can use the display to call other aircraft and ask them for ride reports. This negates the need for 1) the crew to ask the controller for similar information, and 2) the controller to solicit the information from other aircraft. Similarly, flight crews can use the traffic display to observe aircraft deviations around en-route convective weather and to make more informed requests of ATC (such as standard altitude requests), thus reducing the number of nuisance requests (i.e., ones that cannot be granted due to traffic). Most pilots, however, do not know what the separation standards are (and those pilots who are familiar with the standards in general have no way to know which standard the controller is applying). The monetary value of these advantages is difficult to quantify, but airlines are not likely to buy an optional system that can't be demonstrated to pay for itself.

There's no substitute for 'hands-on' training.

The mode of the training will not only affect how and what the user learns, but also how the user feels about it. Training is costly, but it is an investment and shouldn't be considered a luxury. Airlines and Air Traffic Service Providers may need to be reminded that pilots and controllers will be more likely to accept new technology – and hence, realise the operational benefits – when they have the benefit of learning it in an operational context. Ideally, this means incorporating use of the new tool in a simulator. While training in the airplane simulator for all ADS-B applications is not likely to be viewed as cost-effective by the airlines, even an interactive desktop simulator with access to a line check airman for questions helps to build confidence in the equipment and procedure. A briefing sheet or computer-based training (CBT) alone is not likely to be regarded by pilots or controllers as sufficient for a reduced-separation procedure, nor should it be.

You can help to shape the tools you are given and the training you receive by making your voice be heard. With any new tool, the results of initial operating experience are likely to be carefully monitored to identify effects on safety and efficiency.

'Flight crew' extends beyond the cockpit…

All involved parties – pilots, controllers, and dispatchers (where applicable) should have a working understanding of the information and tools being used in the air and on the ground. Knowing which information is used by the pilot, controller, and the automation will help to manage expectations. This was seen in the implementation of Traffic Alert and Collision Avoidance System (TCAS). While pilots understood that TCAS could only 'see' aircraft with Mode C transponders, pilots and controllers alike were frustrated when situations would resulted in a TCAS Resolution Advisory (RA) for the pilot, but not a conflict alert for the controller. Once it was understood that TCAS didn't have flight plan information (and so, did not know 'intent'), and that it used very different algorithms than the controller's automation, the system was seen as being more 'predictable' (a.k.a. 'trustworthy').

You're in charge.

You can help to shape the tools you are given and the training you receive by making your voice be heard. With any new tool, the results of initial operating experience are likely to be carefully monitored to identify effects on safety and efficiency. This should include soliciting feedback from users, often in the form of questionnaires. While it will be tempting to rush off to your next task or well-deserved break, USE YOUR VOICE to identify any relevant area (training, procedures, tools) that need to change to make the tool work for you. There is likely to be some information that must be manually entered (also known as the care and feeding of the computer) – your feedback can help to maximize the return on your investment.

Share your knowledge. Have you discovered an off-label advantage or 'unintended benefit' of the new tool (like pilots using the ADS-B display of traffic to see who may be ahead of them in customs cues and planning accordingly)? If so, pass it along.

It's in everyone's best interests to realise the operational benefits associated with new technology—ride quality, fuel savings, and other efficiencies. Most controllers and pilots are driven to provide the best possible service with the highest level of safety. You need, and deserve, the organizational support in place before, during, and after initial implementation of any tool that changes your job. Use your voice – you'll be glad you did.