Anders Ellerstrand

DEALING WITH GAPS IN THE LOOP

Despite advances in technology, human intervention often prevents accidents and more generally ensures that things work, filling in the gaps. Rather than eliminating people from the loop, improving human performance is essential, argues Anders Ellerstrand.

Most people would agree that the global aviation system is an example of a very advanced and complex system, with an excellent

KEY POINTS

- **Systems aren't perfect:** Safety-critical systems may be very well designed, but they are not perfect.
- **Human intervention mitigates system flaws:** Good system performance is not achieved despite the human problems, but because of our ability to mitigate flaws that exist even in a very well-designed system.
- **Automation cannot replace human adaptability:** Humans possess the creativity, experience, and flexibility to manage complex, unpredictable scenarios that automation struggles to handle, such as severe weather deviations or system malfunctions. Humans can navigate competing goals, adapting their decisions based on the context.
- **Human performance is essential to safety:** Rather than removing humans from the loop in safety-critical systems, efforts should focus on enhancing human performance and maintaining the human contribution to system safety.

Most people would agree that the global aviation system is an example of a very advanced and complex system, with an excellent safety record.. The recent ICAO Fourteenth Air Navigation Conference reported that "the global accident rate decreased to 1.87 accidents per million departures in 2023, down from 2.05 in 2022." So, we have a mature and well-performing aviation system. But it's not perfect. The imperfections tend to be put down to the human contribution, and the concept of having the human in the loop is increasingly questioned.

We know there are problems with us, the human parts. We have limitations. We make errors. There is unwanted variation in our performance. And we are somewhat unpredictable. And, on top of that, we are expensive, while everyone is trying hard to reduce costs in a competitive world. It might seem to make sense to replace humans, or gradually take them out of the loop, only performing the things we cannot yet automate, and not making too many decisions.

This option often comes up whether we are talking about safety, efficiency or capacity. However, I think we tend to underestimate the very positive role of people in the system, to keep the system working. When designing a system, we try to imagine everything that could happen and make sure that we either have automation to handle those situations, or procedures to tell humans how to do it. But there are lots of everyday and long-term problems with these technologies and procedures. And sometimes, situations occur that no one imagined. As a result, there is simply no effective automation or procedure describing how to manage the situation. We tend to forget the role of the human in mitigating these problems. I will try to give you an idea of what I mean via a few examples from experience.

> "We tend to underestimate the very positive role of people in the system, to keep the system working."

MITIGATING RADAR FAILURE

An ATC centre once experienced radar failure. There were no alarms and no obvious reason for the failure. The problem disappeared after some time. Afterwards, the investigation concluded that intensive solar storm activity at the time of sunrise was the cause. No-one expected that to be possible. But humans were in the loop, both technicians and ATCOs, and humans don´t stop working just because they lack instructions. Noticing that not all radar systems were affected in the same way, it was possible to adapt and improvise to look for ways to handle the problem. It was a serious incident, but thanks to the humans in the loop, there was no real risk of an accident.

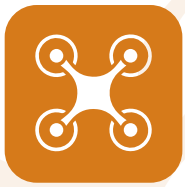
> "Humans don´t stop working just because they lack instructions."

SEVERE WEATHER MANAGEMENT

Sometimes we know about things that could or probably will happen, but procedures are still inadequate. One example that I have been looking into is handling a severe weather situation. This typically includes aircraft changing their route to avoid thunderclouds. A system to manage traffic flows based on horizontally separated routes could become useless as aircraft start to leave their routes to avoid thunderclouds. As part of this work, I interviewed pilots and ATCO colleagues, who told me that severe weather management is covered poorly in both pilot and ATCO training curricula, and that standard operating procedures are often limited. For example, the ICAO standard phraseology does not provide much support. I worked as an ATCO for 40 years and can´t remember any formal training or procedures aimed at handling weather avoidance.

But lacking instructions does not mean that the human stops handling the situation. Experienced colleagues' knowledge is transmitted to less experienced colleagues, even if it is not in the curriculum. Creativity and adaptation provide workable methods in challenging solutions. Some of my interviewees were actually hesitant about the idea of introducing standards. One reason is that two situations are never the same, and a lack of procedures can give the necessary room for flexible adaptation.

Imagine designing an automated system that is going to handle a complex thundercloud situation, with traffic deviating in large parts of the airspace, without the human in the loop.



DEALING WITH DRONES AND OTHER RAPID DEVELOPMENTS

The world is constantly changing but the design of methods to handle new problems tends to lag behind. One obvious example concerns drones. We are told that drones are technically capable of lots of new things, but there is a lack of regulations, procedures and training. In my old job as a Watch Supervisor in an ATC centre, I remember when we started getting phone calls from drone operators seeking permission to fly in restricted airspace. Initially,

we were not prepared for this. Temporary solutions had to be invented quickly – like a blank piece of paper to document the permissions we gave. Thereafter, procedures and methods were designed. Similar things happen all the time. For instance, aircraft were suddenly able to fly offset, but ATCOs had not yet received training or even information about it. Still, the situation was handled, because we have the human in the loop.

PREVENTING AND RECOVERING FROM SYSTEM CRASHES

I remember in my early days as a Watch Supervisor. One part of our then very modern ATM system occasionally 'crashed'. No-one knew exactly why, but our technical staff found out that if we did a proactive reboot of that system once a week, we could avoid the crashes. Eventually, a more durable and permanent solution was found.

I also remember a time when all controllers were told, in an ad hoc written procedure, not to use a certain tool in the system. The reason was that using that tool in a certain context could cause the whole system to crash. With humans in the loop, it is possible to adjust the system very quickly to avoid the unwanted effects of design errors and other 'gaps in the loop'.

ONLY PEOPLE CAN HANDLE GAPS IN THE SYSTEM

Technical systems tend to be very good at doing what they are told to do, in a predictable way. But many situations cannot be foreseen, and solutions cannot be programmed or prescribed, so our human ability to adapt is very valuable. With my examples, I am claiming that our systems are far from being good enough to be managed without the human contribution.

"When humans confront a new, unforeseen situation, we are often creative enough to invent a way to solve it."

Having the human in the loop is very often the best risk mitigation we have. Of course, recruitment and selection must be done properly. And people need to be provided with quality training and continuous information, and have sufficient experience. But given this, when humans confront a new, unforeseen situation, we are often creative enough to invent a way to solve it. Every day, perhaps every second, humans are filling the gaps in the system. And most of the time, we see that as a normal part of what we do; nothing extraordinary, and nothing requiring a report. But as a result, we lack the statistics to demonstrate that most system flaws are mitigated by the human in the loop. So we must make more time to recognise and understand the human contribution, and better support the humans in the loop so that people stay in control.

ANDERS ELLERSTRAND is presently an ATM consultant, supporting EUROCONTROL in Brussels. Before retirement from the Swedish air navigation service provider LFV, he was an ATCO and a watch supervisor. His background also includes work for ICAO in African countries, safety work for LFV and an MSc Human Factors in Aviation with Coventry University.