

Human-centred automation for ATM

by Professor Sidney Dekker

When NextGen was not yet a word, Charlie Billings had just retired from NASA (the National Aeronautics and Space Administration in the US) and taken up a position as professor at The Ohio State University.

Dr. Billings, who had been one of the main people behind the confidential Aviation Safety Reporting System (ASRS), employed me as his Graduate Research Assistant to help in the development of a book about human-centred aviation automation. The book came out in 1996.



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In it, from the credibility and perspective of an insider and well-known figure in the field, Charlie was one of the first to 'lay down the law' of human-centred aviation automation systems. I say 'lay down the law' because that is pretty much what he did—unabashedly so. He put down the standard. 'Look,' he said, 'if the human remains responsible for safety, then the human must retain the authority with which to exercise that responsibility, by whatever means. Automation must be a tool over which the human must have full authority.' There was already sufficient cause for concern over this very principle at the time - in their enthusiastic embrace of what was then known as Free Flight, researchers and policy makers were willing to acknowledge that human controllers were not going to be able to detect all conflicts in random routes and that they would thus have to rely on automation to do that for them. 'But how could that be?' Charlie asked. 'Ultimately, we will hold the human controller responsible. And you cannot hold someone responsible for something over which they don't have full authority.' The argument made pretty good sense to me.

In a field with as much technical competence and prowess as air traffic management, there is always the risk that developments will not be driven by human-centred principles. The risk is that they are technology-driven, and that the result is technology-centred systems. These are the kinds of systems

that can generate the kinds of wacky error messages that implicitly accuse humans of not thinking and behaving like machines. You probably know what I mean. But these are also systems that take an increasing amount of cognitive, planning and decision-making work away from the humans who remain ultimately responsible for the outcome. That is not just a practical or technical dilemma, it is an ethical one. As we are in the midst of another wave of technology-driven developments in creating next-generation air traffic management systems, it is probably a very good idea to go back to some first principles. What would Charlie have said, have warned, have reminded us of? Here are some of the most important points (called premise, axiom and corollaries, but don't worry about that too much):

Premise:

- Controllers bear the responsibility for traffic separation and safe traffic flow.


Axiom:

- Controllers must remain in command of air traffic.

Corollaries:

- The controller must be actively involved in the process.
- The controller must be adequately informed of what is going on in the process.
- The controller must be able to monitor the automation assisting them.
- The automated systems must therefore be predictable.
- The automated systems must also be able to monitor its human operators.
- Every intelligent system, whether automated or human, must know the intent of other intelligent systems involved in running the process.

Charlie had good reasons to lay down the law the way he did. He had already come across automated systems that limited the controller's authority, without it even being obvious to the human operator that this had occurred. To him, this was not only unsafe and unethical, it was also an expression of a lack of trust between the developers and managers of a system on the one hand, and its human controllers on the other. If human controllers were not given full authority, and were not fully informed of what their automated systems were doing or why they were doing it, were the controllers actually trusted to do the right thing, to be the professionals they were? What did this say about our confidence in our fellow human beings? This concerned Charlie greatly. And indeed, a lack of involvement in process control, and not being adequately informed of what the automation has been doing, has led to inevitable 'automation surprises.' These would be avoidable if we followed the human-centred principles above. Are controllers still fully 'in command of air traffic'? Are they actively involved and adequately informed? Are the automated systems we are developing today sufficiently predictable, so that human controllers have a good sense of what their intent is? Let those questions ring around your head and around your community for a little while. See where the answers land. Probably not all on the side of human-centred developments!

Relying on automation research giants like Earl Wiener, Charlie reminded his readers (as he reminds us today) that 'the experience from commercial aviation shows that it is unwise to dream of automating human fallibility out of a system. Automation essentially relocates and changes the nature and consequences of human error, rather than removing it, and, on balance, the human operator provides an irreplaceable check on the system.' Charlie liked to quote Dr Ruffell Smith, an aviation human factors pioneer, who said in 1949 that 'Man is not as good as a black box for certain specific things. However, he is more flexible and reliable. He is easily maintained and can be manufactured by relatively unskilled labor.' Charlie Billings, who was born in 1929 in Boston and started his career as a flight surgeon, passed away in 2010. In the global enthusiasm for more technology-driven systems, reminders of his first principles can go a long way in moderating and enriching the discussion of what and how we should automate and advance our ATM systems even today. 

Billings, C. E. (1996). *Aviation automation: The search for a human-centered approach*. Mahwah, N.J., Lawrence Erlbaum Associates.

