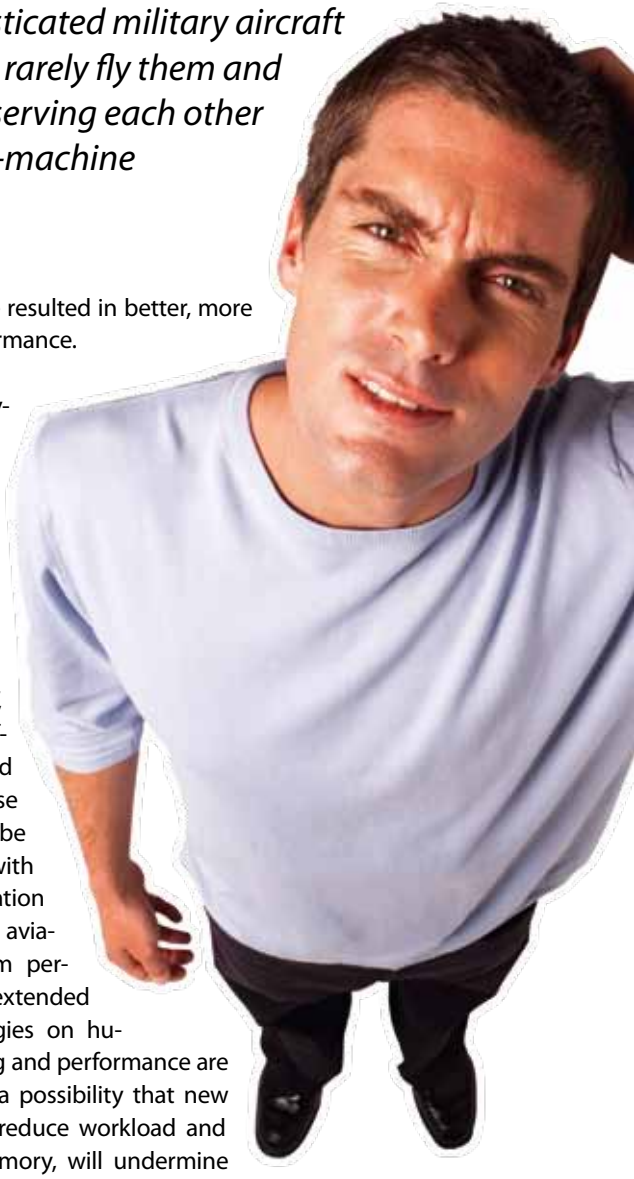
"So what's it doing now?" Training in new technology environments

by Anne Isaac and David Lord

"Fifteen foot banks of identical switches with small code numbers displayed in a nuclear power plant, sophisticated military aircraft that are so expensive to operate the pilots rarely fly them and ships that collide while the officers are observing each other on anti-collision radar all suggest human-machine problems in high technology systems"



Defining the problem

Engineers typically design machines according to engineering principles, rather than behavioural principles. That is, when a machine has been designed, relatively little consideration may have been given to how easy it is for a person to use or operate. Life is filled with such examples. In some cases, the poor design is a nuisance and not particularly dangerous, such as the size of door handles or the placement of spare tyres in cars that require you to unpack the entire boot to access. In others, the design is positively hazardous, such as the placement in some new control consoles of the switch to 'amend flight information' next to the 'screen shutdown' button.

There are several reasons why engineering principles dominate the design field. Many engineers who have not had the benefit of human factors training believe that humans are able to adapt readily to almost any environment in which they are placed; whether a work place is too hot or cold, too quiet or noisy, humans manage to perform their work. The real question, however, is whether they perform these jobs adequately and safely, and whether another design would have resulted in better, more economical and safer performance.

The assumption underlying the implementation of new technologies, such as electronic flight data systems, is that with the automation of functions which were once allocated to human control, the processing resources of the operator, their 'spare capacity', will be freed to deal more effectively with other required tasks. However, while the use of new technologies may be essential in order to deal with the ever increasing information processing demands of the aviation system, the long-term performance implications of extended use of the new technologies on human information processing and performance are largely unknown. There is a possibility that new technologies, intended to reduce workload and consequently enhance memory, will undermine situation awareness and safe aviation practices. There is a need for the task demands of the aviation system to keep the operators alert and actively involved in meaningful ways.

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Operational complexity versus functional capability

Issues for pilots:
the further difficulties of co-ordinating the new technologies, and human capabilities, between the flight-deck and air traffic control environments?

There are some significant differences between the abilities of machines and the skills, abilities and traits of humans, and it is crucial in all high-risk environments in which new technologies are introduced, to research carefully how these two very capable 'systems' work together optimally. These principles of human-centered automation (Billings, 1991) advocate the design of automated systems with the human operator at the centre, rather than trying to exclude them. However, it can be seen that many new technological systems are often designed and installed only with regard for the operator's ergonomic requirements with no consideration from a systemic or operational stand point.

> *To consider human factors properly at the design stage is costly, but the cost is paid only once. If the operator must compensate for incorrect design in his training programme, the price must be paid every day. And what is worse, we can never be sure that when the chips are down the correct response will be made.*
>
> Or, as Rudyard Kipling put it:
>
> *But remember please, the law by which we live,*
> *We are not built to comprehend a lie,*
> *We can neither love, nor pity nor forgive –*
> *If you make a slip in handling us,*
> *You die.*
>
> *The Secrets of Machines*

Issues for both teams/crews:
Until pilots and controllers are provided with effective means of mastering the automation and technology in their workplace, with training processes and operating protocols that ensure survival, the successful reversion to manual core skills and standardised protocols for the avoidance or mitigation of technology-related errors and hazards, we are likely to go on hearing the phrase…

"So what's it doing now?"

It is therefore essential for both ANSPs and airlines which introduce new technology, to follow Billings' principles of automation. The three areas which need constant and comprehensive consideration are the selection of the right technology, the development of appropriate procedures and the selection of the most appropriate training.

- Selection of appropriate human/machine technology – it is essential that an automation philosophy, policy and guiding principles be developed to enhance the choices made when new technology is introduced and multi-disciplinary teams work together to detail the interface and operability of these advanced systems. It should also be realised that the more complex systems become, the less the operators will understand the linkages between the different teams and their specialist functions.

- Development of appropriate and robust procedures – legacy procedures are often adopted when new technology is introduced, in the belief that the operational staff will behave in the same way. Technology usually brings at least two behavioural changes; first, the operators will quickly adapt to the support which the technology brings, becoming less involved in thinking and intervention. Secondly the operators assume that the technology is always correct and become less 'afraid' of dealing with failures since they are rarely seen. Both these behaviours can lead to slow adaption and sometimes misuse of procedures which are often so subtle that the system itself does not recognise the degradation.

- The development of new and appropriate training materials and methods – automation requires behavioural modification in the operating environment. These different behaviours and problem-solving techniques must be identified, possibly from the automation principles, and highlighted in the training at ab-initio level. There is also a need for both controllers and pilots (and in many cases engineers) to collectively share their learning in a collaborative approach to cross-disciplinary aviation training.

Dave: Open the pod bay doors, HAL.
HAL: I'm sorry, Dave. I'm afraid I can't do that...
Dave: HAL, I won't argue with you any more! Open the doors!
HAL: I know you and Frank were planning to disconnect me. And that's something I cannot allow to happen...

Stanley Kubrick's 2001: A Space Odyssey, 1968