

occur and pictures of an AUV and an ROV and references to a successful AUV cable-laying mission in the Arctic that was only achieved because of fault-tolerant operation. The use of neural networks is mentioned in connection with this type of application.

The two remaining chapters are on "Failure Detection, Identification and Reconfiguration in Flight Control" and "Nonlinear Fault Detection for Hydraulic Systems". The latter may seem somewhat specialized, but is important because hydraulic actuators are critical components of robotic devices that enter hazardous environments. The chapter on flight control is largely with reference to a tailless fighter aircraft in which failure tolerance is carried to the extreme where even physical damage to flight surfaces can be allowed for. This is only possible with redundancy of control, such that the available control actions have extra degrees of freedom. The switch to a new control mode is made quickly and automatically following damage.

The book gives a valuable introduction to what is obviously an extremely important development area.

Alex M. Andrew  
95 Finch Road  
Earley  
Reading RG6 7JX  
(UK)

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#### **HUMANS AND AUTOMATION: SYSTEM DESIGN AND RESEARCH ISSUES,**

by Thomas B. Sheridan,

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The relationship between humans and automation is examined from numerous points of view, with important implications for designers. The overall message is that the design of modern systems requires attention to human factors as much as to engineering considerations, and engineers are often not equipped to deal with them. Accounts are given of systems that have failed because of lack of appreciation of human factors.

The author begins by reviewing different meanings that have been attached to the term automation, which originally meant the mechanization of manual processes in the Industrial Revolution. A somewhat different complexion came with feedback control typified by the Watt governor, and an entirely different one with the advent of modern technology and computers. In many modern environments, humans interact with automation in highly complex ways. Examples are the control of nuclear reactors and other plant, and the training and supervision of industrial robots. Other examples are associated with transport, especially air transport, where aircraft embody many forms of automation, as does also ground Air Traffic Control.

The author's care to define his subject area is typical of his careful analytic approach. He treats his topics in a chatty and readable way, with the small amount of necessary mathematics relegated to an Appendix. However, this care over fundamentals, and apparent simplicity, should not obscure the profundity and importance of the conclusions reached. These are soundly argued, and backed up by numerous references to the literature and to practical findings, often in the form of accounts of disasters.

The book is in three Parts, of which the first is on Background. It includes the discussion of meanings to be attached to the term automation and reviews many contexts in which humans interact, or may in future interact, with automatic systems. These include education and entertainment, and such things as Virtual Reality and telesurgery and the "smart home", and hospital and office automation. References to transport range very widely and include traffic management for roads and railways as well as various possibilities for autonomous vehicles, and applications to space travel and underwater exploration.

The second Part is the largest of the three and is on Design of Human-Automation Systems. A first consideration is to decide what can usefully be automated and one approach is to make a "MABA-MABA" list, where one of the groups of letters stands for "machines are best at" and the other for "men are best at". Although forming the list is a useful exercise, its apparent suggestions should not be followed slavishly, and the aim should be, in biological terms, symbiosis between man and machine.

As in Air Traffic Control, the function of the machine may be to inform and advise a human operator. Such a function may include predictive displays which make it easier to control a remote device where there are time delays either because the device is on a remote planet or because the signals have to pass through the Internet. A predictive display can also be useful in navigating a large vessel, where the display can be made to show what will be the situation if the current rudder setting and speed are maintained for some suitable length of time.

An important question is that of deciding when a human should be able to override an automatic system, and also when an automatic system should override manual control. In some aircraft, the pilot is automatically prevented from putting the craft into certain positions that are considered dangerous. The conditions under which a human may take over from an automatic system include the obvious one of system malfunction, and also situations where it is impossible to satisfy all of the goals, and the allocation of priorities has to be made according to essentially human criteria. Where a human operator may have to intervene, it is of course important that his alertness and "situation awareness" are maintained.

These and many other issues are fully treated in the book. The need for clear displays is illustrated by the observation that an expensive pilotless plane was lost because the operator flying it remotely made a mistake about which mode of display was currently on his screen. Another use of automation can be to monitor human performance and it is suggested that people who are getting on in years might check whether they really ought to be still driving by having an automatic device check speeds and distances of separation from other vehicles. The author is sympathetic about this and refers to the inconvenience and loss of self-esteem when the decision to give up driving has eventually to be faced!

The third Part deals with what are termed Generic Research Issues and these include examination of the alienation that may result from automation as well as its part in social and economic relations more widely. Problems arise from both misplaced trust and misplaced distrust of automation, and from the loss of personal dignity when a person becomes a "button-pusher".

All these issues, and others, are treated in this important work that can be read with profit by anyone involved in the design of interactive systems. Most such readers will want to keep it handy for future reference.

Alex M. Andrew  
95 Finch Road  
Earley  
Reading RG6 7JX  
(UK)