[Moov Over, It S Glen Wexler](#)

5. *Reasoning.* As we shall see later, automatic computers are superior in speed and accuracy to human brains in deductive reasoning, but no success has been attained in constructing a machine which can perform inductive reasoning. Inductive reasoning is that peculiar ability which mathematicians and scientists use when they formulate new principles on the basis of masses of empirical data. The original idea that formed the basis for Einstein's theory is an example of inductive reasoning although many of the later refinements of the theory probably have resulted from the process of deduction.

In summary then, we can see that the human carries within him some remarkable powers that cannot yet be duplicated by machines, especially abilities needed to deal with changing situations and unforeseen problems.

What Can Machines Do Better Than Men?

Humans, however, do have many faults as well as good points and it behooves us to list these as well. In general, machines excel humans in the kinds of things we have already turned over to them in our society--especially tasks requiring great strength, and tasks of a very routine nature.

1. *Speed and Power.* Although machines do not have many of the sensory and perceptual capacities that humans do, they far excel people in the ability to respond quickly and powerfully. Even under ideal conditions a man requires over 0.1 second before he can start to move a control in response to a signal, while in most normal work situations his lag time is even longer. Milton and others (1947), for example,
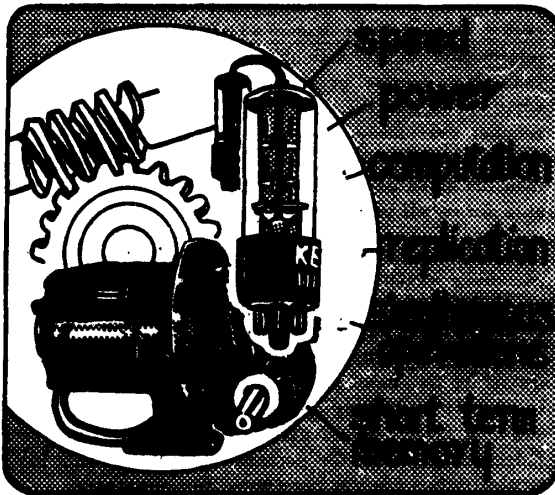
measured pilot reaction time in the air and found an average lag of 1.55 seconds before they initiated a movement in instrument recovery problems. The time was 1.35 seconds for contact recoveries. In these experiments pilots were blindfolded and disoriented, then shown either their instrument panel or the ground and asked to re-orient and level the aircraft. An auto-

pilot would, of course, respond much more quickly. Machines can be devised to make movements smoother, faster, and with greater power than humans.

2. *Routine Work.* Machines excel humans in repetitive, routine tasks. Machines can be counted on to make fewer errors in routine tasks, and to turn out responses that not only are quicker, but are far more uniform than a person can make. They also do not become bored and inattentive.

3. *Computation.* Machines are more efficient computers than humans--no matter whether the computations are simple or complex. In the latter case, a machine can examine all the possible deductions from sets of postulates, reject those which are invalid, and act upon those which are valid. It is important to remember, however, that the rules of operation, the postualtes, must be built into the machine.

4. *Short-term Storage.* Machines appear to excel humans in short-term memory. There are many jobs in our present society that call for short-term storage of information, followed by complete erasure of the data in preparation for another task. Machines can be built with this kind of memory. Humans, on the other hand, are not so good at it. They especially have difficulty in completely erasing information in short-term storage. Also, it is sometimes difficult to be sure that a man has noticed and remembered a particular fact--this is why controllers often ask pilots to verify that they have understood certain critical information.

5. *Simultaneous Activities.* Finally, a complex machine is capable of carrying on more different activities simultaneously than is a single human being. We are talking here about decisions and activities requiring some degree of attention--not reflex or automatic processes like breathing. There is much information to indicate that when he has to employ his highest intellectual abilities man is essentially a one-channel computer--he can only work effectively at solving one problem or attending to one thing at a time. Only when activities have been greatly overlearned can he do several things at once very effectively and even then he may actually have to shift back and forth rapidly between the two activities. The only way to get around this human limitation is by adding more men to do the job.

These are some of the things we can say with confidence about the relative abilities of men and machines. They provide a starting point. However, it is obvious that we need much more information of this sort--more specific information about human capabilities and limitations in performing different tasks-- before we can determine the optimum division of labor between men and machines.

We turn next to the question of division of responsibility between different human beings in the air-navigation and traffic-control system.

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