

# CONSIDERATIONS FOR DEVELOPING REMOTE-CONTROL TOOLS

V. L. J. DiRito

Aeronautical Systems Division  
Wright-Patterson Air Force Base, Ohio

Until recently, with only certain exceptions, tools have been designed to perform specific functions regardless of the manner in which they were to be used or the type of person using them. Although frequently impairing the efficiency of the worker performing a mechanical task, no great effort was made to take into consideration the environmental conditions affecting the work or the difficulty encountered by the worker in adapting himself to the task.

The impact of nuclear energy resulted in a considerable reappraisal of how tools might be made to fit the job, especially when the tools have to be handled remotely. For example, in hot cell work, such as packaging and handling radioactive materials for shipment, preparing radioactive materials for use, and the handling and disposal of radioactive waste, operators handle the material only by remote means with the aid of special tools.

Take the case of a simple open-end wrench. When this wrench is held in the hand, a person is able to perform certain tasks easily and rapidly. However, the use of this same tool in a hot cell behind thick shielding walls imposes certain restrictions that are difficult to overcome. Even though the human arms can be replaced by direct-linkage mechanical manipulators extending through a shielded barrier, so that the fingers of the manipulator become the thumb and forefinger of the operator, the required stability effected by the remaining three digits of the human hand is missing. This difficulty was overcome by encasing the stem of the wrench in plastic and serrating the sides for better gripping. Although this did not attain the control effected by the entire human hand, it provided a useful degree of control. Even assuming this open-end wrench were functionally 100% efficient, the added burden of having to perform the task remotely would still require a great deal of time to perform simple tasks. One way of compensating for this limitation is to replace tools such as wrenches, screw drivers, etc., with electric motors and/or air motors. This has resulted in considerable efficiency and speed. Moreover, this has been accomplished with tools of standard design that were available commercially.

Another condition that adds to the problem of remote mechanical manipulation is the restriction imposed by a confined area such as a hot cell in which there is not enough room for storing tools of different types. Three ways have been found to solve this problem: first, hot cells have been constructed for specific tasks; second, hot cells have been constructed with drawers and shelves for moving tools in and out; and third, efforts have been made to design and develop multipurpose tools. Of these three ways, the third is the most feasible from the standpoint of efficiency and utility.

In projecting these considerations into advanced systems, it is becoming increasingly evident that there is a striking similarity between certain requirements of hot cells and those of space vehicles.

Factors such as the optimum utilization of a confined area, provisions for vision, arrangement of appurtenances, and maximum use of a minimum number of tools are common to both. However, one notable exception to the similarity is that the hot cell operator works outside the hot cell, while the astronaut works inside a space vehicle or suit.

In actual practice, the hot cell operator, though hampered to some degree, is not entirely restricted in his selection and number of tools, whereas a limitation is imposed upon the selection and numbers of tools available to the astronaut. This fact presents a strong argument for an increased effort in the design and development of multipurpose tools. Now the questions arise: what tools would an astronaut require to perform his job in space? Should we investigate tools in general? Should we investigate the items to be worked on possibly to design space craft and equipment to be joined by means of quick-disconnects with self-locking feature, thus eliminating the need for hand tools?