MASTER

THE CRAFTY CRANES, OR THE FEASIBILITY OF ROBOTS AT ISABELLE *

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INTRODUCTION

NOTICE
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As currently envisioned, ISABELLE will have to be shut down at regular intervals much shorter than the natural lifetime of the beams in order to allow the experimenters into the six experimental halls to make simple repairs or simple modifications to their apparatus.

Much of this downtime and frustration could be avoided if there were a class of radiation workers who could withstand $\sim 10^5$ rads. Obviously such a class of workers would be robots.

TASKS TO BE PERFORMED

The following list of tasks has been compiled by trying to consider what tasks this experimenter normally does when he has to repair his apparatus. It could be expanded by others with differing experience.

1. Look at apparatus, e.g., what is missing?
2. Listen to apparatus, e.g., pump sounds bad.
3. Hang scope probes on electronics.
4. Adjust or turn off power supplies.
5. Change or "shake" cable connections.
6. Change printed circuit cards in electronics.
7. Reposition small pieces of apparatus such as efficiency counters.
8. Supervise the moving of shielding.
9. "Sniff" for gas or vacuum leaks.
10. Fill cold traps, adjust valves, and look at gauges on gas system.

Aside from items 5 and 6, the manual dexterity of the robots need not be very high. In fact, items 1 and 2, which are probably most important, require none at all.

WHAT WOULD THEY LOOK LIKE?

Despite this author's initial science fiction fantasies, there is no need for these robots to be at all anthropomorphic. After all, real moon landers don't look anything like the sleek rockets of Buck Rogers.

A robot that "walks" on the ground requires extra neatness on the part of experimenters to ensure that paths free of cables and piping are left to all parts of the apparatus which might need servicing. R2D2 is cute but impractical!

With the possible exception of the "open areas," all of the experimental halls will have cranes. Cranes are remotely operated

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devices that can move in three dimensions. Obviously, this is a good way to provide mobility to the robots.

Thus, the basic idea is to have a robot consisting of an "eye" and an "ear" on some sort of tentacle with a built-in light source, and one or two "hands" that can do the manipulations required by the tasks listed above (see Fig. 1).

Most of the "intelligence" of the robot could be remote and hence not subject to radiation damage. In fact, the computer controlling the robot could be the experimenter's on-line computer if economy were very important. All of this control could be sent along an umbilical cable so that interference problems would be minimized.

The parts that would be most radiation sensitive would be the television camera--both electronics and lenses--and any hydraulic fluids in the manipulators. There is extensive experience at accelerators with both these matters. Radiation damage to the robot would be considerably reduced by detuning that interaction region.

PROBLEMS

Clumsiness resulting in breakage of apparatus or, worse yet, damage to the ISABELLE accelerator structure is the biggest concern in this author's opinion. A possible method of avoiding damage would be to have some sort of sonar device which senses when the robot is within 1 or 2 m of an object and automatically reduces its speed. Sensors on the body of the robot would bring it to a complete halt if it came in contact with something. Also, special zones around the vacuum pipes could be interlocked so that the robot could enter them only if controlled by qualified personnel.

This would be a new piece of apparatus to break down, but as long as the crane was operational it could be moved out of the way. It is possible that there would be means of bringing the robot outside the experimental hall without turning the machine off. If

Fig. 1. Schematic idea of robot.

such a route were devised, then the robot could even carry replacement parts into the hall.

PRACTICALITY AND COSTS

As far as can be seen, all the technology mentioned above exists today. The most complicated devices would be manipulators designed to allow the experimenter to "feel" remotely what the hands of the robot are doing. Such manipulators are under active study, and certainly would not be exorbitantly expensive by the time ISABELLE begins operation.

The need to reduce radiation exposure at the AGS and other accelerators is another reason for use of these robots. Such applications would allow trials of similar robots prior to turn-on of ISABELLE.