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MAN/MACHINE INTERFACE DEVELOPMENT FOR THE REMOTEX CONCEPT*

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SUMMARY

This paper describes ongoing research at the Oak Ridge National Laboratory (ORNL) to develop a man/machine interface system that can be used to remotely control a system composed of a transporter base and a force-reflecting, servo-controlled manipulator. A unique feature of the concept is the incorporation of totally remote operation. Thus, a major objective is the requirement that an operator have a sense of presence in the remote environment. Man/machine interface requirements for this totally remote operation remain to be developed. Therefore, a simulator is being built to optimize such requirements. These developments are the subject of this paper.

INTRODUCTION

Work on the conceptual design of a pilot-scale plant for reprocessing breeder reactor fuels is underway at ORNL. The plant design will meet all current federal regulations for reprocessing plants and will serve as a prototype for future production plants. A unique feature of this concept is the incorporation of totally remote operation and maintenance of the process equipment within a large barn-like hot cell. This approach, called REMOTEX, uses servomanipulators coupled with television viewing to extend human capabilities into the hostile cell environment. The REMOTEX concept provides significant improvements for fuel reprocessing plants and other nuclear facilities in the areas of safeguarding nuclear materials, reducing radiation exposure to humans, improving plant availability, recovering from unplanned events, and plant decommissioning.

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The success of the REMOTEX concept is probably most dependent on the performance of the remote manipulation, viewing, and maintenance system. A review of other facilities indicates that using more versatile manipulation will result in decreased complexity (and cost) of in-cell equipment and the downtime associated with maintenance. This indication can be substantiated in a number of ways. For example, increasing the dexterity of remote maintenance manipulators to approach that of direct handling may reduce the cost of designing and building such equipment.

Numerous studies and tests have defined dexterity as the time required to perform sets of work tasks using different types of remote manipulators. The general results of these studies are presented in Ref. 1. Dexterity depends on force reflection (kinesthetic sensing), tactile feedback, visual feedback, and audio feedback. Therefore, we hypothesized that by maximizing properly filtered feedback, the effectiveness of our teleoperated systems would also be maximized. Optimally, the man/machine interface provides information feedback from the work environment that allows the operator to react in "real time" and to provide feedforward information into the work place.

APPROACH TO SIMULATOR DEVELOPMENT

The development of the man/machine interface at ORNL began with a state-of-the-art literature search of studies on related systems. This search revealed a need for emphasizing visual systems and the types of teleoperated servomanipulator controls.

Conceptual design of the ORNL system will continue with the testing of prototypes. The prototypes are evaluated at the subsystem level described in Ref. 2 and then undergo a full system test in a simulated environment (the simulator).

The simulator is an integrated man/machine interface that contains all of the subsystems in a modular form. These subsystems consist of imaging closed circuit television, graphic display, audio system, manipulator controls, camera controls and selectors, transporter controller, and auxiliary control systems.

This man/machine interface is then coupled to a remote handling system and a simulated nuclear fuel recycling environment. A series of generic tasks have been selected using a detailed time and motion study based on similar facilities and the current conceptual design.

The evaluation and selection of each man/machine subsystem will then depend on system test evaluations and the performance of the teleoperated system.

STATUS

The man/machine interface simulator is 90% complete (see Figs. 1 and 2). Figure 1 shows an artist's concept of the optimized system using one operator man/machine interface. Figure 2 shows the man/machine interface module as currently assembled.

FUTURE PLANS

Immediate plans for future work include the following:

1. Design of in-cell, small-volume work tasks appropriate to a simulated chemical process module;
2. Evaluation of small-volume coverage cameras for large-volume usage; and
3. Evaluation of small- and large-volume cameras for obstacle avoidance.

Longer-range goals include system optimization for the following:

1. Larger volume, less dextrous manipulator tasks; and
2. Transporter deployment.

REFERENCES

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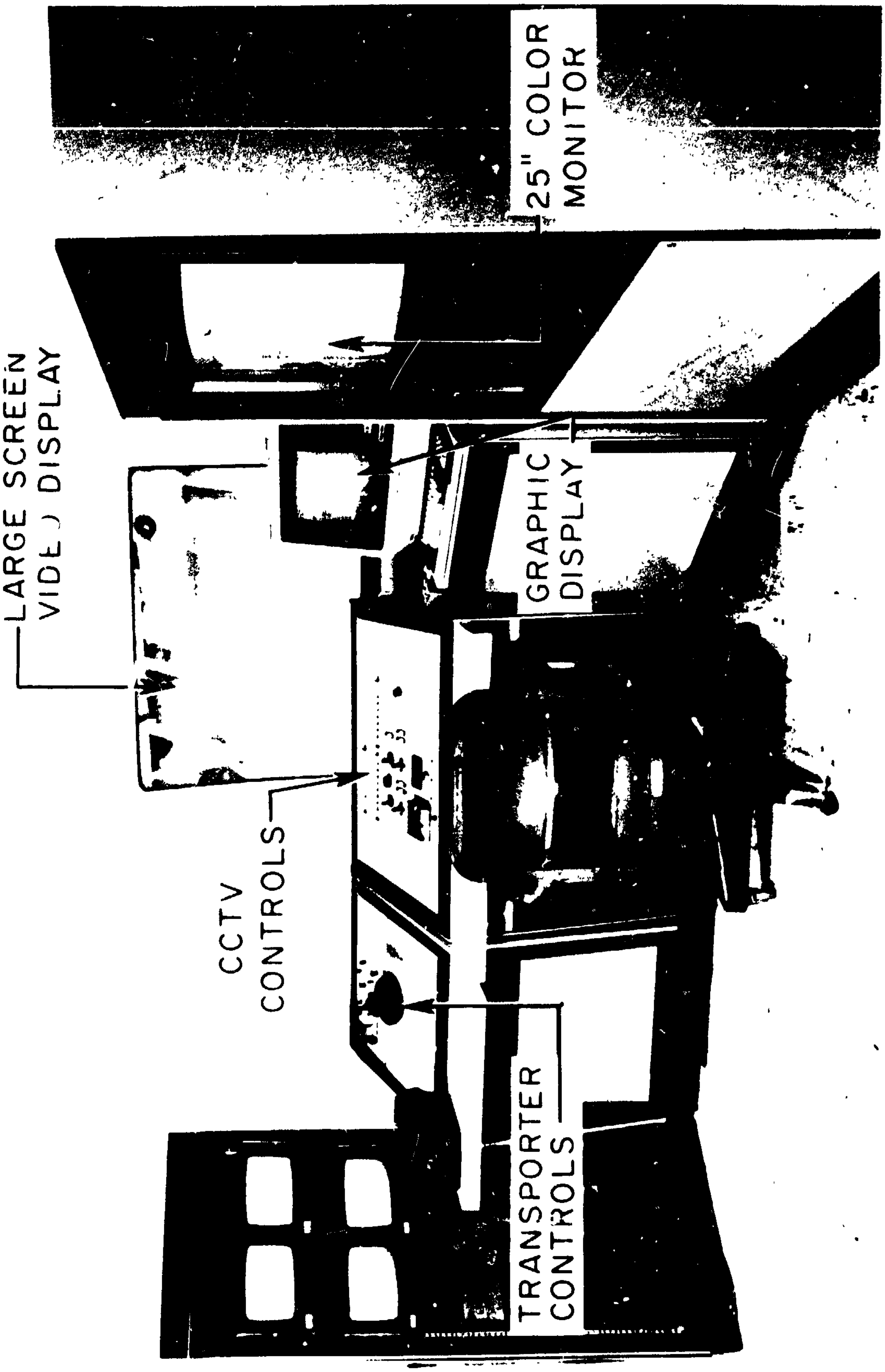

Fig. 1

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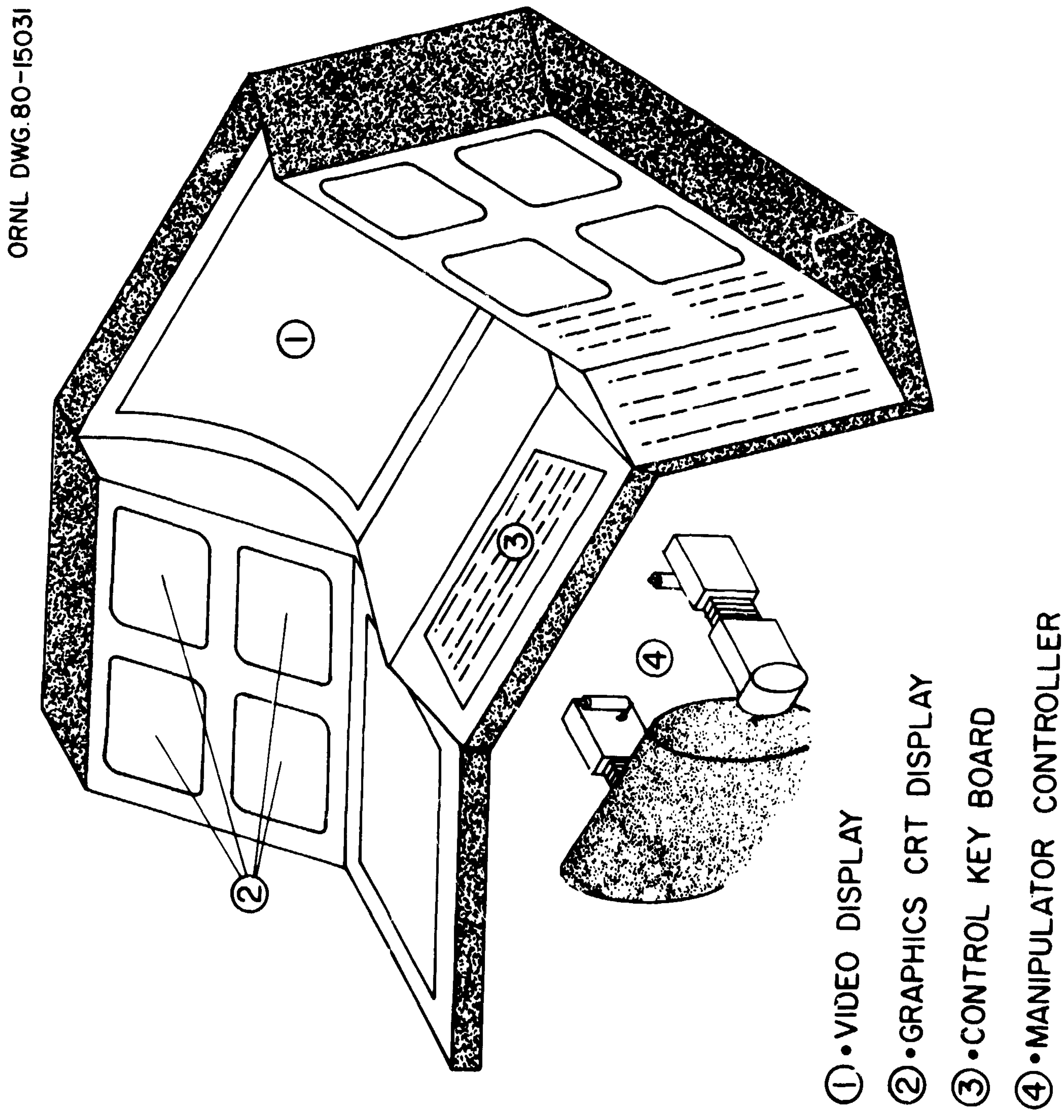

Fig. 2