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Thema:

ERGONOMIC ASPECTS OF SHIP DESIGN, IN PARTICULAR WITH REGARD TO SHIP'S BRIDGES AND WHEELHOUSES

Static and Dynamic Simulation

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ergonomics
man-machine systems
experiments
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Static and Dynamic Simulation

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Summary

To optimize the man-machine relationship there are two different approaches. The adaptation of man to machine and at the other hand machine to man. The first mentioned approach is dealing with training and selection, the latter is considering the adaptation of the machine to given human characteristics, generally called Human Engineering.
At the present time the research in the field of Human Engineering, in relation to maritime operations, concentrates mainly on the design of appropriate lay-out of all control elements installed on board.
The working tool for this ergonomic research is simulation.
Mock-ups (static simulation of the work-environment in future) can be built to study an appropriate lay-out of the workspot. If the man is to work as an operator of control element with the machine then the dynamics of the machine are to be simulated and adapted to the limited dynamics of the human operator.
The aim of this type of studies is an increasing of the effectiveness of the man/machine systems and a contribution to the well-being of the individual.
Applications of these techniques are discussed.

Introduction

The control of the safe conduct of vessels is still increasing in complexity. There are a number of factors which contribute to this situation. The increasing density of the ship traffic in confined areas, the increasing speed of vessels, the grow of the dimensions, sea pollution, automation and the decreasing number of crew are some of these factors.

All these factors are related to man/machine systems and, as is shown in accident statistics, groundings and collisions are often due to personnel failure.

A rough estimation of the overall dimensions of the needed room is based on studies of the relations of man to man, man to instrument and instrument to instrument, although, of the old system.
After this system analysis the mock-up is built. Therefore, use is made of antropometric data, data concerning the illuminations, data of room to walk, noise, climate, a.o.

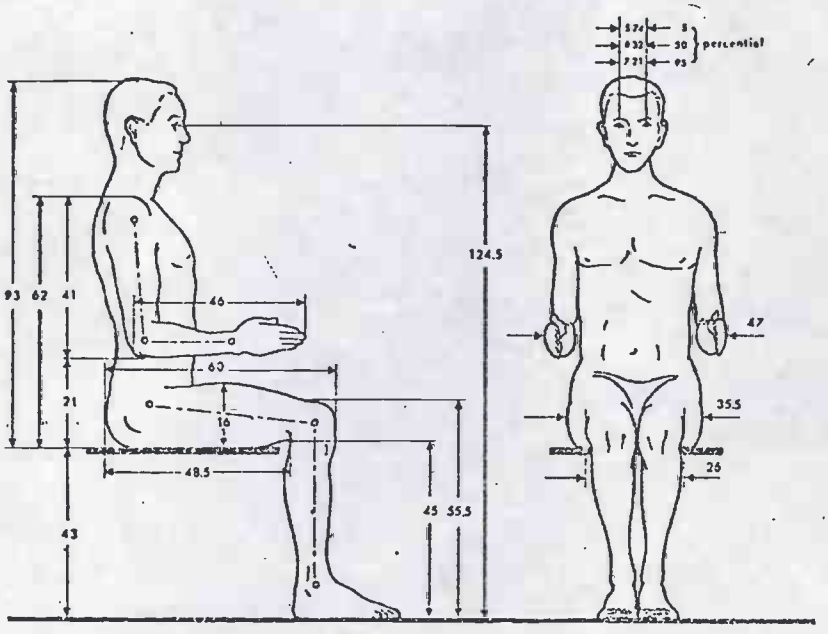

Fig. 2. Antropometric data of the man sitting behind a console (50th percentile).

When this first state of the study, building the mock-up is finished, the users in future are invited to judge their environment.
This can be done by the use of questionnaires. It is possible to compare one lay-out of a room with another, because it is very easy to rearrange the lay-out of the mock-up.
From the questionnaires can be concluded what important elements are from the point of view of the users in this environment. When two or more lay-outs, instruments etc. are compared is the use of questionnaires an objective way to give preference to a certain lay-out (Fig. 3).
The advantages and disadvantages can be summarized as follows:
a. It is possible to judge the workspot of the new system.
b. Changes in the design are not necessary after the system is built.
c. Low costs of the mock-up in relation to displacing instrument when the

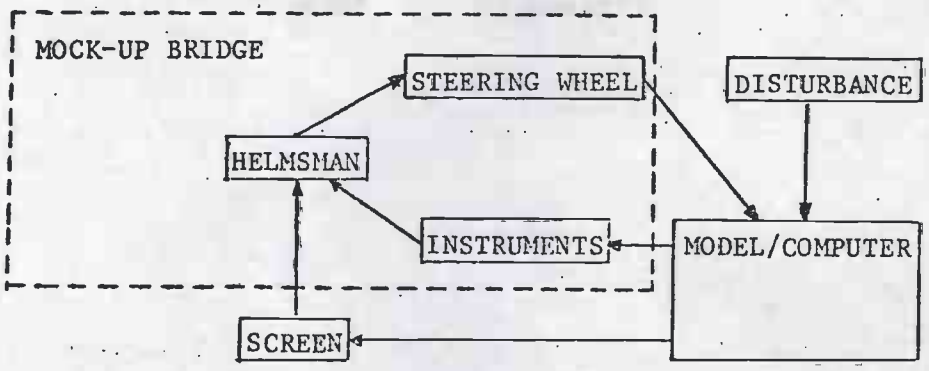

Fig. 4. Block-diagram of a dynamic simulation.

An example of a dynamic simulation in which the operator acts on signals, is given by the design of the engine control room of the new Dutch Frigates. This control centre is designed to give a general view of the ship status, with respect to main and auxiliary engines, the electrical control. It is possible in a limited way to control apparatus from this room (Fig.5, p.6). As the design of this room was initially supported by a static mock-up, it appeared that procedures, particularly the manual control of the gas turbines when failures arose, should be studied.
A part of the installation is watched by an automatic system (DECCA-Ises 300) and a part by alarms, directly connected to sensors. In addition there are signals indicating the status of a separate apparatus. Therefore a dynamic simulation was built with help of a digital and analog computer. Also it is now possible to train the operators on procedures for the handling of the engines (Fig. 6, p. 7).

The simulation can be controlled partially by an instructor or totally by the computer. Registration of the handlings is written on a teletype. The criterions used here are the time required by the operator to stop an alarm and the accuracy of his maneuvres.

In the cases that the display means a representation of a large part of the environment of the ship, the goals of the study has to be taken into account.

To determine the controls of a bouy-tending vessel, for example, it was possible to compare in simulation under the same circumstances several technical solutions of the controls.

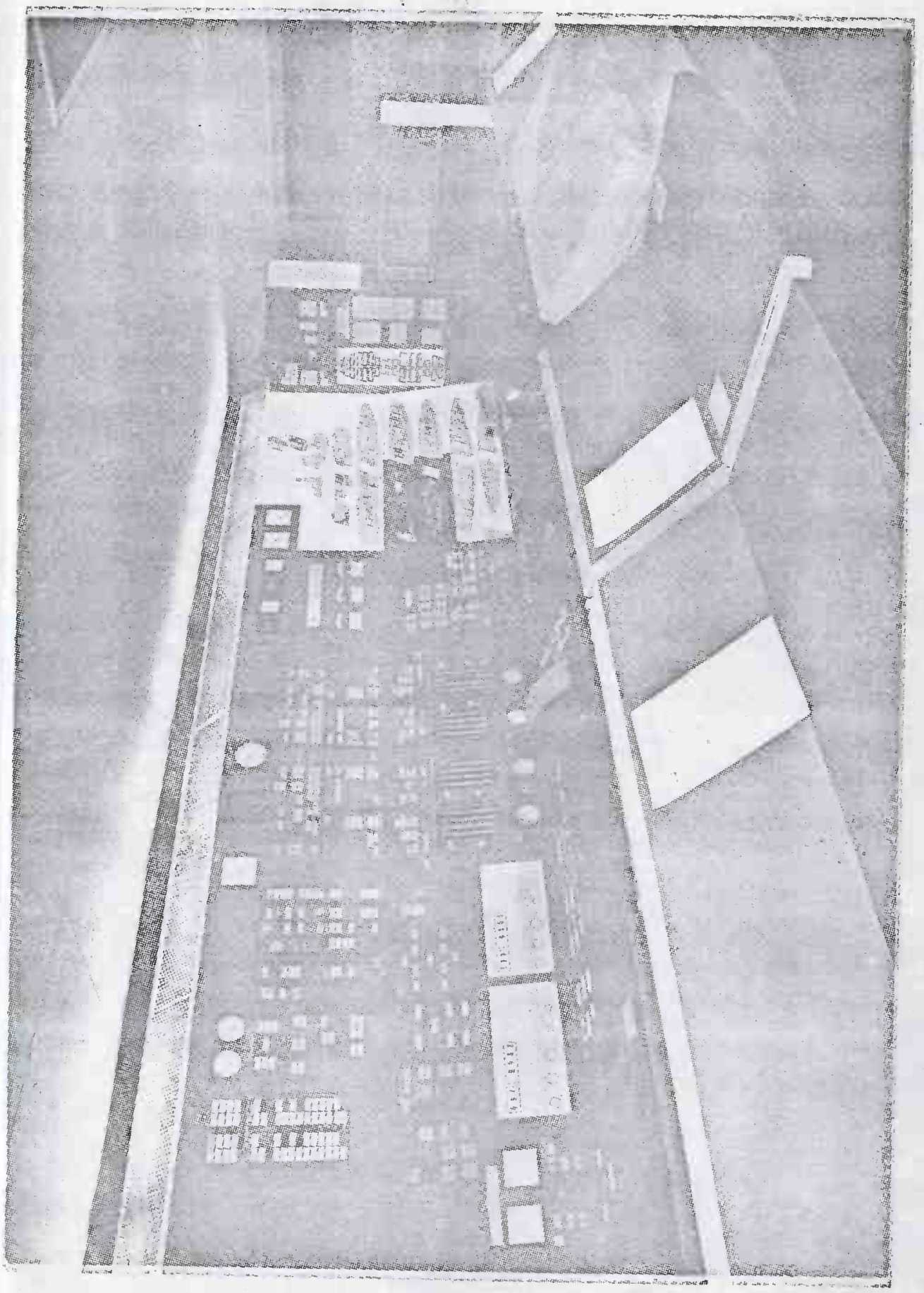

Fig. 5. Photograph of the mock-up of the E.C.R. of the new Dutch Frigates.

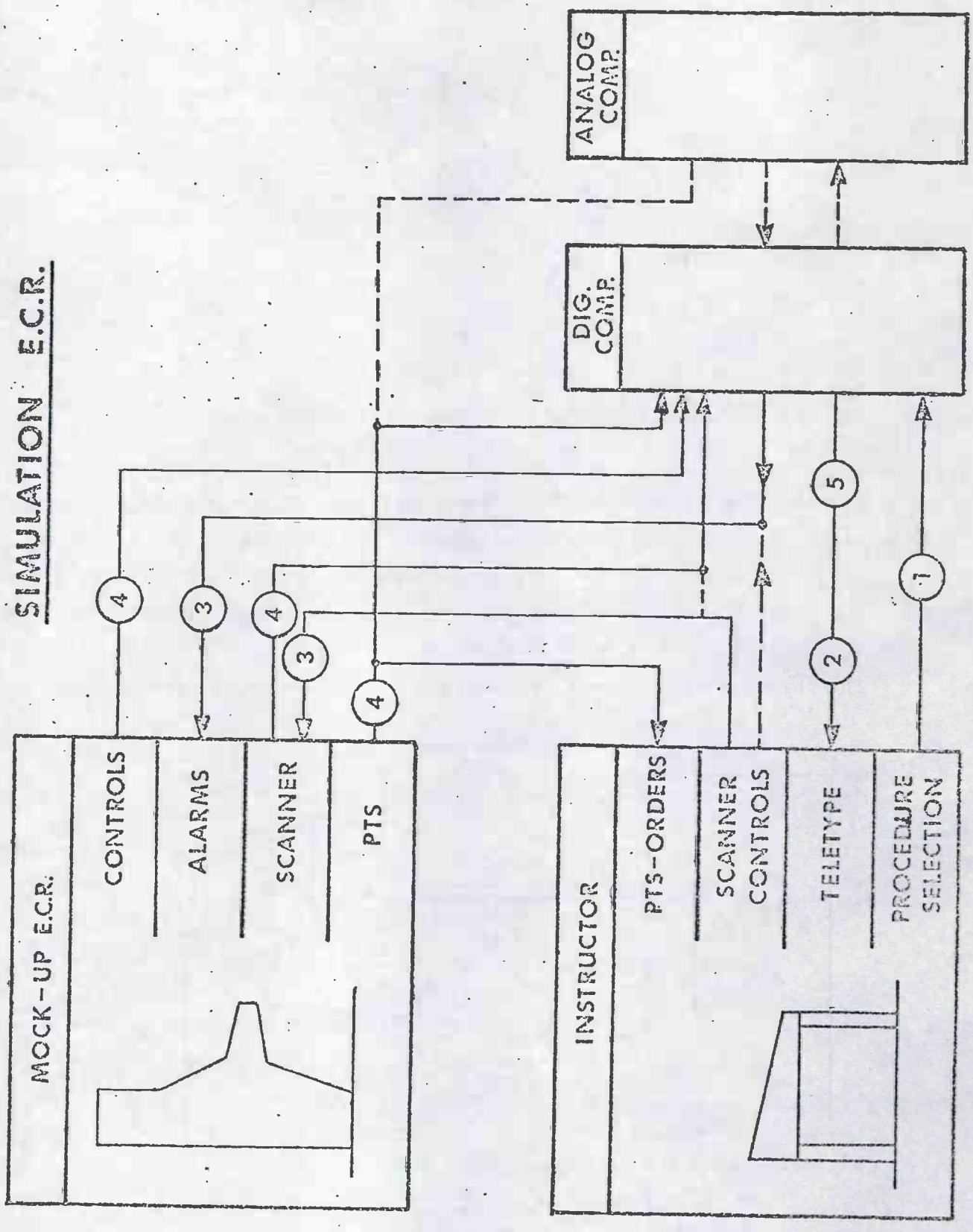

Fig. 6. Scheme of the partially dynamic simulations of the engines of the new Dutch Frigates.

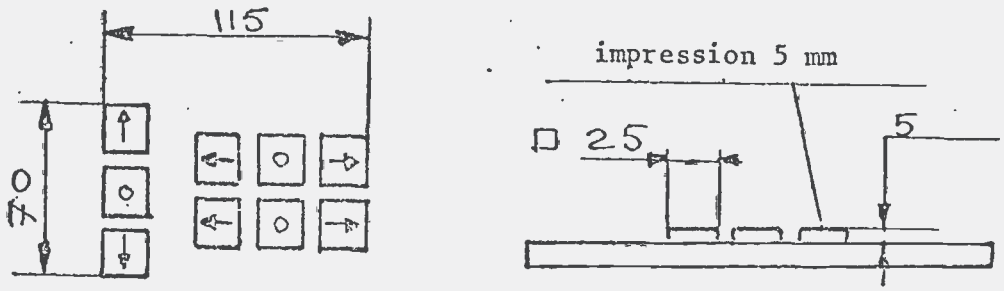

Fig. 9. Push button system.

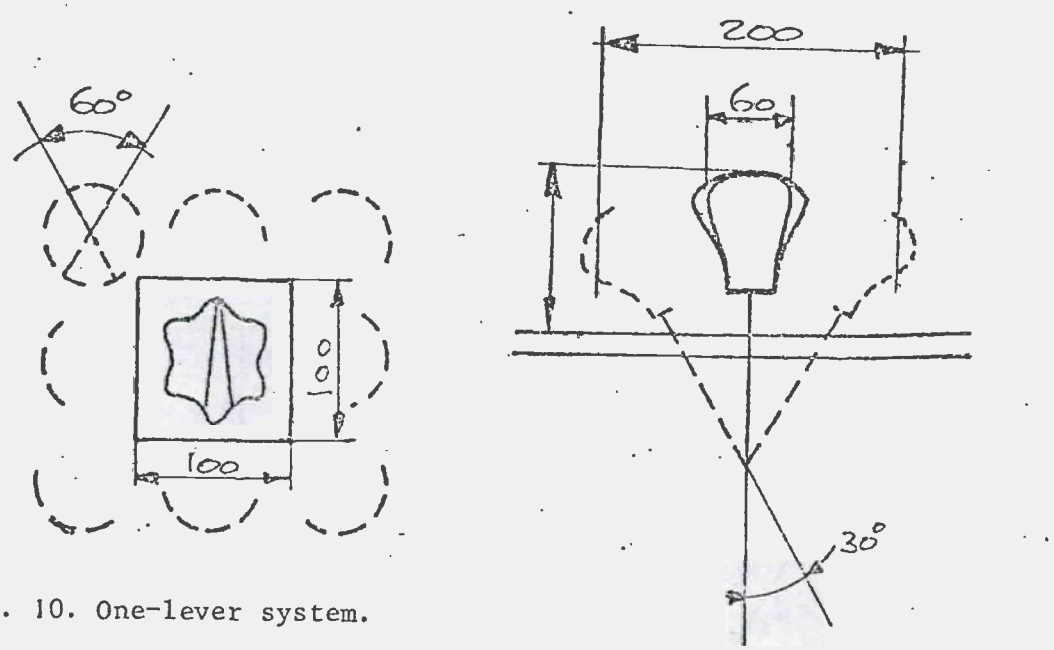

Fig. 10. One-lever system.

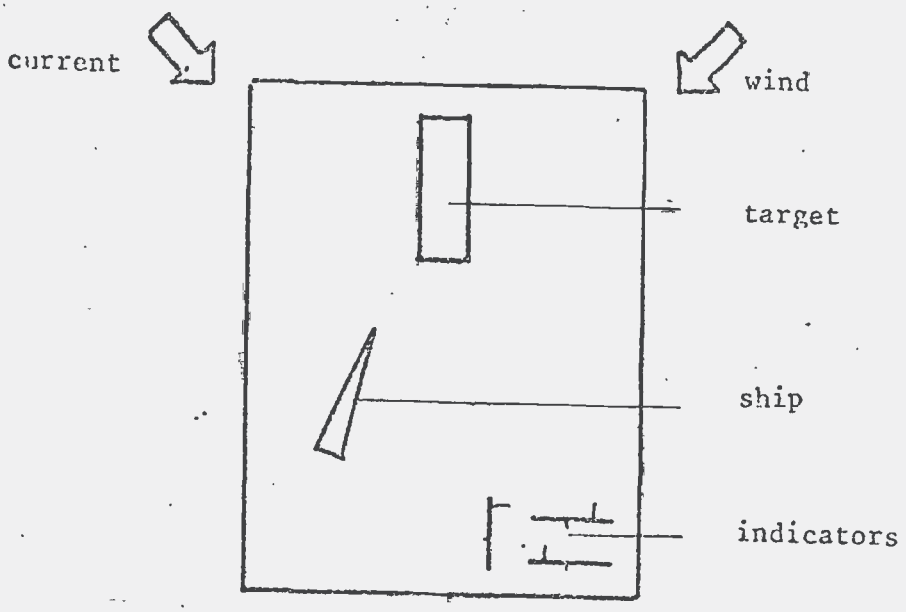

Fig. 11. Display with symbols of the target and ship. In the right corner indications of speed and direction of the revolutions of the propeller and the thrusters.

When it is very important to gather information from the very large field as is the environment of a ship normally, special care has to be taken to generate the environmental display. In that case it is also important to create facilities to recognize other ships in the vicinity and to estimate their speed and moving direction.
Therefore in our institute is evaluated an visual simulator to generate this picture. On the exhibition a proto type can be seen.

In a scale model 1:100 or 1:500, representing a harbour entrance with ship traffic, a TV camera-carrier is moving (Fig. 15, p. 12), according to the ship characteristics calculated by a computer. The video-picture is projected by a TV-projection system on a screen about 8 m wide. The ship is steered by the mate of the watch on the bridge (Fig. 16, p. 13).

In all these situations subjects are asked to fulfill tasks such as keeping the ship near the buoy, entering the harbour etc.
The environmental conditions are systematically changed. Their influence can be measured with the objective parameters, like sailed course, time that the ship is kept near the target, time before a failure on the console of the ECC is taken away, etc.
Comparing these parameters it can be concluded that in specific conditions an optimum for the man/machine relationship exists.

This kind of simulation gives an opportunity to study effects and to recognize parameters of the environment (instrument and locations of instruments inside the bridge, as well as ship traffic, guiding lights outside the bridge).
These parameters have to be compared and a decision can be made for a optimum man/machine relationship, before the system is realized.

With this type of Human Engineering research a contribution can be made to ship's-safety and the well-being of the individual.

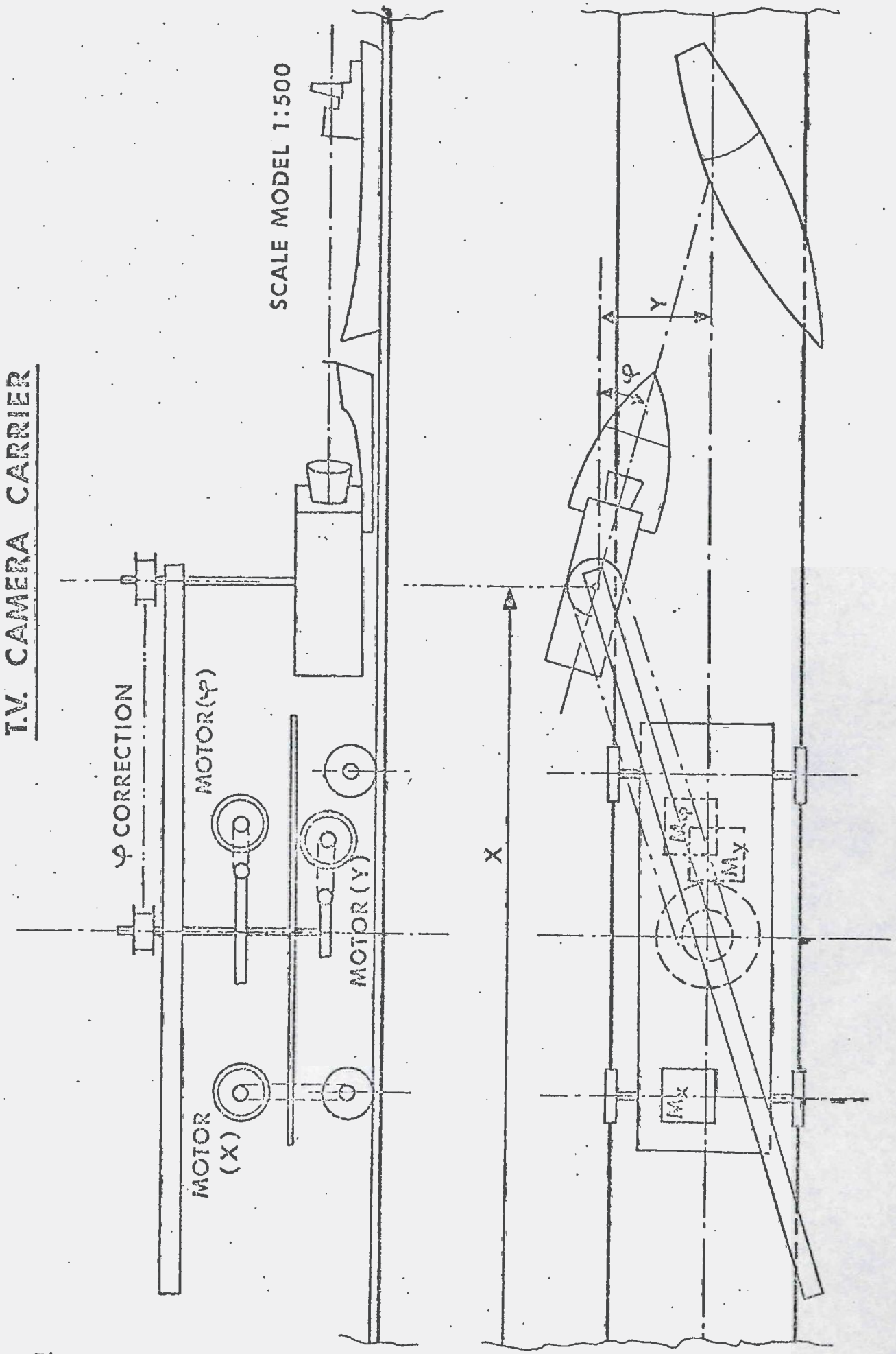

Fig. 15. Detail of the dynamic simulation. A TV camera-carrier is used to generate an environmental display.

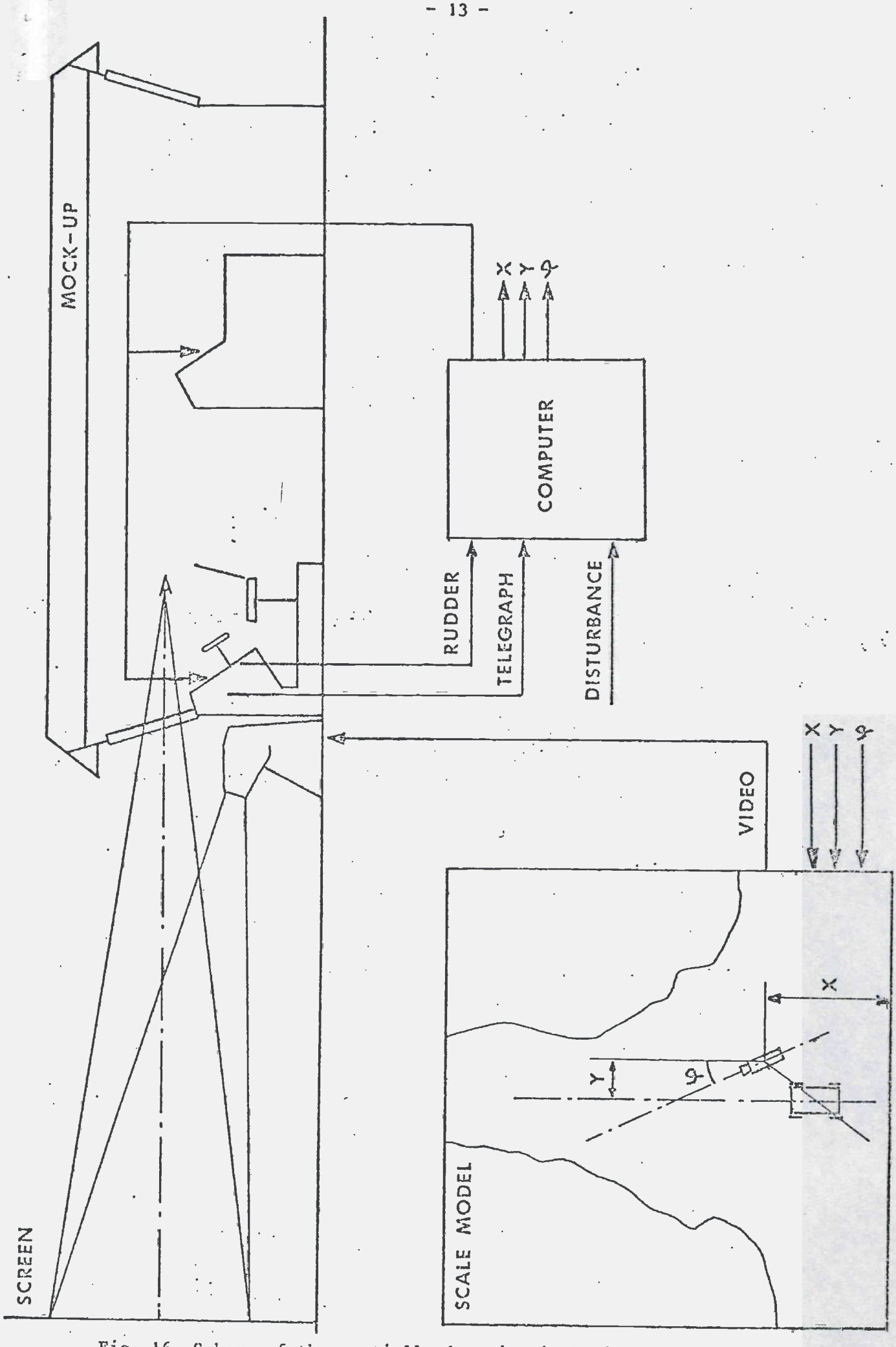

Fig. 16. Scheme of the partially dynamic simulation of bridges with the use of an environmental display.