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**Robotics in Construction  
State of the Art  
in the Federal Republic  
of Germany**

**Abstract:**

The aim of this paper is to explain current trends in the design of construction machines and the influence of electronics in the control of these units.

The paper is based on information by German manufacturers at the BAUMA-fair in Munich April 1986.

Altogether three systems of considerable interest related to the subject of robotics were presented:

- o hydraulic excavator equipped with the CAL-system from O & K
- o mast for concrete pumping, 4 axes equipped with a controller from Putzmeister
- o mast with a platform for repair work from Ruthmann

## 1. Introduction

As far as machinery for construction is concerned we distinguish machinery categories:

- o for fixed installation (e.g. fabrication of wall sections). Here we have a more or less structured environment.
- o for construction sites (e.g. excavators, cranes). The environment is unstructured - the machinery has to be mobil.

The range of possible applications for robots might include both categories if we include hybrid controlled machines.

At present fully autonomous robots cannot cope with the more difficult environmental conditions more or less common in the construction industry. However, a partially controlled robot (teleoperator/robot) can be developed within the present state of art. Such a system is economically viable for the majority of these tasks. Often used tasks would be called up by the operator to be performed in automatic mode, seldom occurring tasks would be performed by an operator who supplies most of the 'intelligence'.

Following the presentation at the 'BAUMA 86' in Munich we have to note the fact that all developments in direction of robots are more or less related to the hybrid control.

## 2. Hybrid controlled hydraulic excavator

The company Orenstein & Koppel (Dortmund) presented the so called CAL-system (Computer aided loading) with their excavators type RH90C and RH20 (see Photo 1)

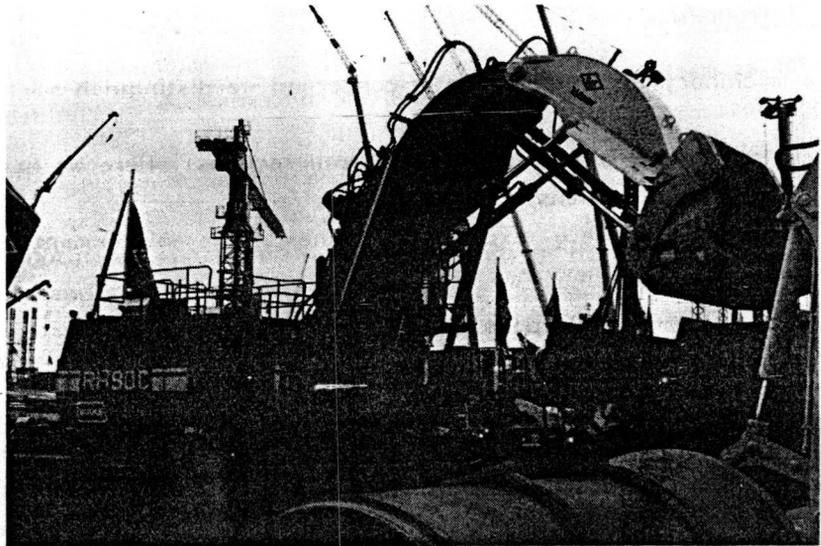
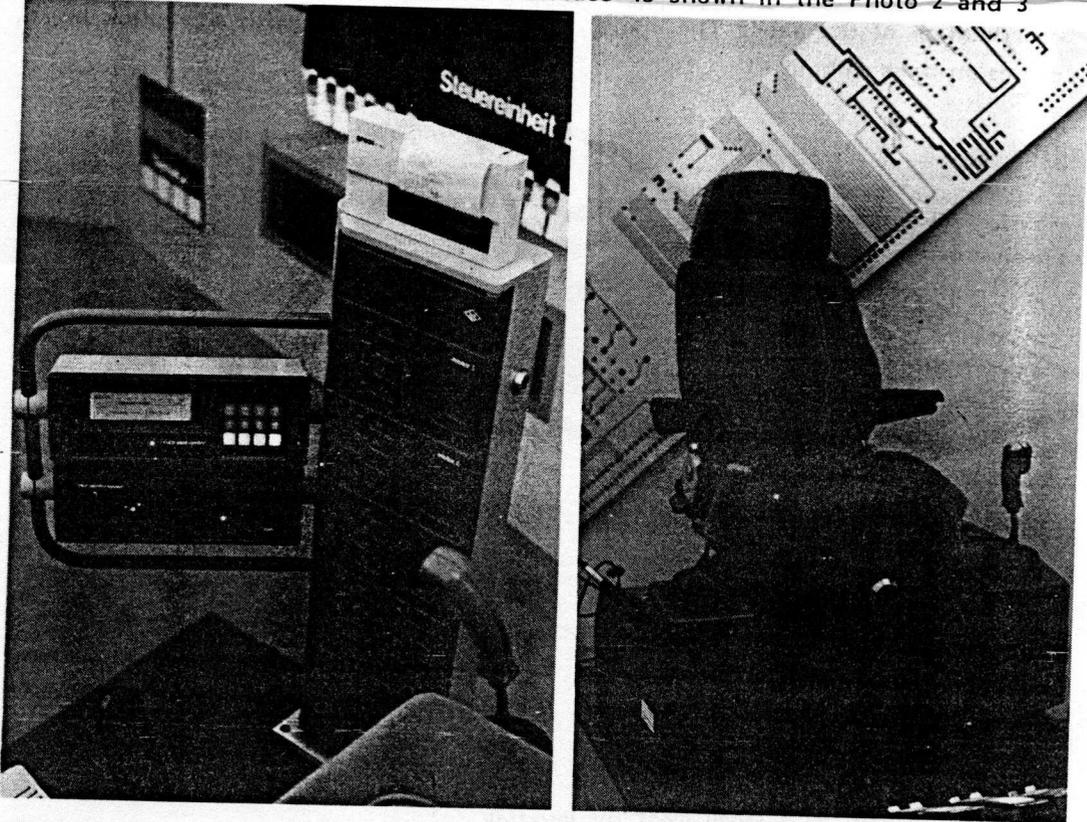


Photo 1: Hydraulic excavator RH90C equipped with the CAL-system  
(Photo: Wanner)

The CAL-package includes a controller for hybrid control and a board control with diagnostic functions for the Diesel-engine, gearbox, hydraulic and electronic components. Some data related to the controller is given below:

- Teach-In with joystick
- PTP-control. Linear interpolation between the teached points
- Incremental path measuring system for the programmable axes
- Price for the controller about 3% of the total cost of the unit (as far as the RH90C is concerned)

An overview of the 'man - machine interface' is shown in the Photo 2 and 3



Photos 2 and 3: Chair with joysticks for the hybrid control (left),  
board control (Photos: Wanner)

The main advantages of the system were given by the supplier as:

- approx. 20% reduction in the overall cycle time
- approx. 30% reduction in energy consumption

### 3. Boom - mast for concrete pumping

The Putzmeister - company (Aichtal) showed a boom-mast (reach 42 m) for concrete pumping equipped with the AMC controller (Automatic mast control).

The controller has three subsystems:

- coordination of the axes. The operator can move the mast with a joystick in cartesian axes (Photo 4)

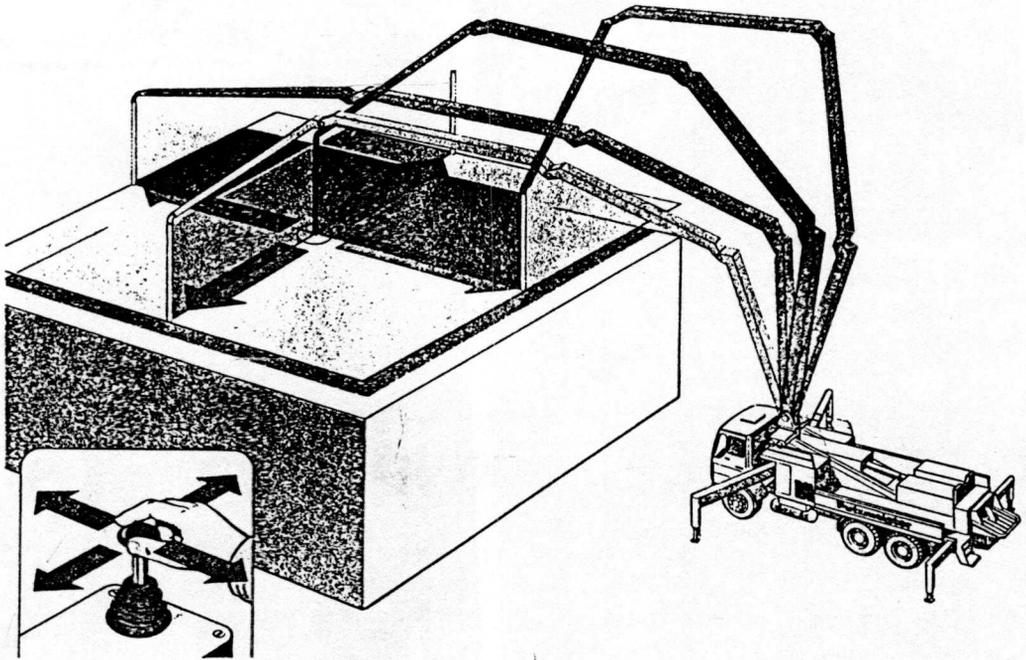


Photo 4: Control of a boom mast by joystick

- automatic control of the folding process
- automatic stability control of the overall system

Most important in this system is the coordination of the axes which might lead to further developments. The costs for the controller are very small compared with the price for the total system.

#### 4. Mast with a platform for repair work

A mast with a computer controlled stabilized platform was shown by the Ruthmann company, Gescher. The kinematic chain consists three rotatory and two translatory axes, still seperatly controlled by the operator. This development can be regarded as a minor step towards robotization.

#### 5. Conclusion

To conclude this overview we can see a step by step procedure towards robotization starting with existing machinery. It should be noted that all three examples presented in this paper caused considerable interest from potential customers.

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