DIGITAL CONTROL

PROGRESS IN THE ROYAL NAVY

BY

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This article is an edited version of the opening paper given by the author at the Seventh Ship Control Systems Symposium, at the University of Bath, on 24th September 1984.

Background

The U.K. practical investigations into the possible applications of digital techniques to machinery control and surveillance commenced in 1978 with the establishment of the Demonstrator Project[1,2]. This utilized digital technology both in the control and surveillance task and to simulate the actual ship machinery that had to be controlled for evaluation of the system at RAE, West Drayton.

The Project was successfully completed in 1983, having proved that digital techniques for control and surveillance of propulsion machinery was feasible and cost-effective and that it should be the way ahead. It also confirmed the applicability of digital techniques to the machinery simulation role which could be considered at least as important an application of digital techniques as control and surveillance.

The Demonstrator Project enabled the Ministry of Defence confidently to commit the Type 23 frigate control and surveillance system design to a microprocessor-based digital scheme.

It taught us several major lessons which are summarized here:

(*a*) Distributed microprocessor-based systems are both viable and attractive.

(*b*) Attempting cost saving by reducing documentation is counter-productive.

(*c*) Careful definition of the problem to be solved, at the outset, is important.

(*d*) Hardware and software should not be developed simultaneously; software should be developed first, then hardware found to meet the identified need.

(*e*) The time response to microprocessor-based systems when working in real time needs careful specification and management.

(*f*) Great care is needed in providing adequate diagnostic facilities to ensure that such systems are maintainable.

Applications

We have now (1984) arrived at a system design philosophy based on distributed digital microprocessors. The system to be produced for the Type 23 frigate by Vosper Thornycroft Controls will be based on the INTEL 8086 processor. There will be a period of evaluation ashore at RAE, West Drayton, utilizing digital processors to simulate the ship machinery package. This will give design feedback well before the shipborne setting-to-work and trials.

During the design of these systems, the implementation of the new technologies has overcome the natural resistance to change from methods which have apparently worked well in the past and the suspicion of that invisible control mechanism called software. These attitudes have had a significant influence on the end system in that the Type 23 machinery control and surveillance system still contains large quantities of dedicated circuits in parallel with digital data links. The current configuration does not make the most of digital technology but is a step in the transition from a total analogue technology to a software-controlled digital one. The control and surveillance system depends ultimately upon the transducer on the plant, which in turn feeds the on-plant controllers. Conventionally, local control panels are based upon analogue technology and this necessitates special interfacing electronics if the shipborne system is to be digitally based. Utilization of digital-based local control panel facilities with data link capability avoids this interface problem and several such units are currently under detailed assessment.

In general we find that the solution of the control problem is less difficult than the solution of the surveillance needs. The current aim to reduce manpower in ships impacts immediately upon the design, implying an increase in automatic surveillance and improvements in man/machine interfaces. Efficiency in design and acceptance of new technologies have to compensate for the reduced numbers of watchkeepers. In the Type 23 frigate the watchkeeping numbers in the cruising state have been reduced by 50 per cent. in comparison with the Type 22. As a result of this reduction, the number of parameters under surveillance in the Ship Control Centre has increased by 500 per cent. This increase results from the use of a centralized presentation to compensate for the fewer roundsmen.

This massive increase in surveillance requirements can be met in an ideal manner by the use of data collection units and digital data links. The new technology can match the effects of manpower reductions in this area. I believe that digital electronics offer the only cost-effective solution to this problem, and increasing sophistication will be able to cater for the associated topic of condition monitoring of equipment. However, the cost of electronic equipment is still falling and this is leading to change of priorities among the procurement agencies. Thus transducer costs now exceed those of electronics in surveillance systems. Furthermore the cost of production is falling with no change in the cost of development; indeed in many cases the development cost for software-based products can be expected to rise.

Man/Machine Interface

Where does the man fit into all this? Such a radical change in terms of maintenance loading presents a considerable challenge to the established manning structure associated with our ships. Is it reasonable to expect any engineer to be able to maintain systems ranging from gas turbines, shafting, diesel engines and chilled water pumps through to complex microprocessor-based systems? Clearly the training task is of major importance as is the need to build good diagnostic facilities into systems. We are addressing both these areas vigorously. We are conscious that other navies have created separate specialists or have allocated responsibility for new generation control systems to weapon specialists who are already familiar with such electronic systems.

Thus, as far as shipwide systems are concerned, we are currently in the midst of a period of consolidation and confidence building, having taken the step from analogue to digital systems. Sight has not been lost of the fact that man and machine are themselves essentially analogue in nature. Thus it is not surprising that there are no digital display devices in the probable propulsion panel for the Type 23 (FIG. 1).

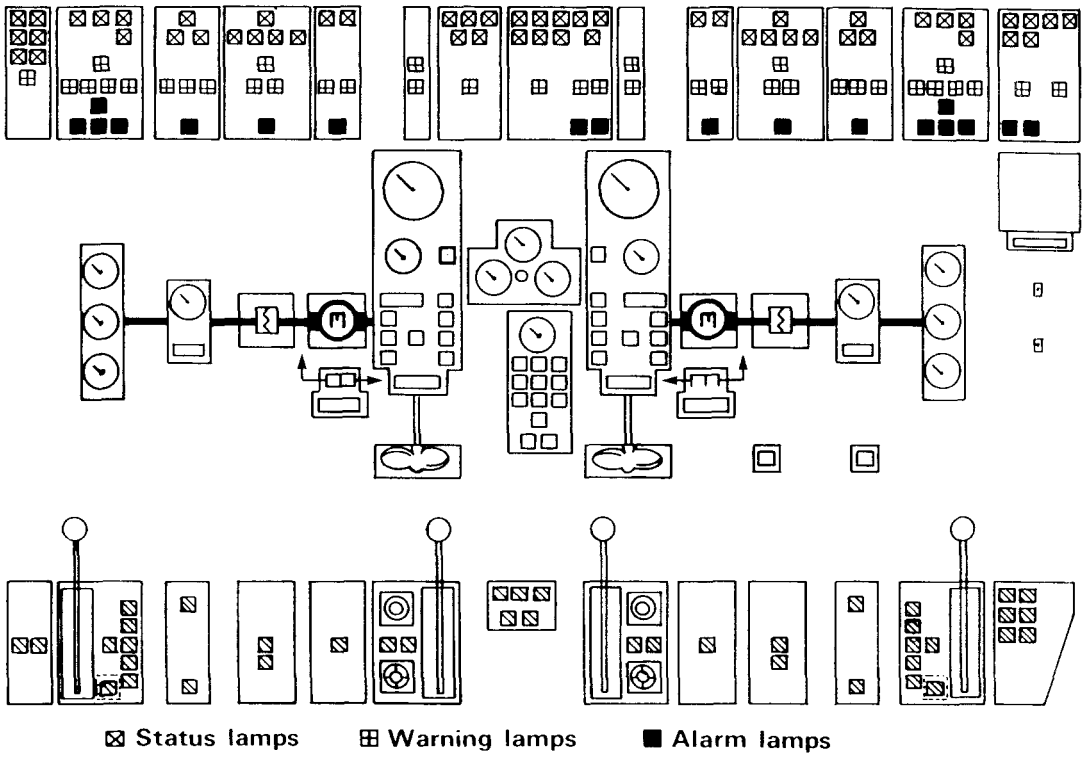

FIG. 1—TYPE 23 PROPULSION PANEL

Future Trends

As we learn more about the enormous potential of digital technology its applications will increase in the machinery control and surveillance field.

The industrial base of Great Britain involved in micro-processor technology has burgeoned with considerable speed over the past five years. As the Navy now tends to follow commercial advances rather than lead them, it is inevitable that control solutions using digital technology will be offered for future requirements for ships as they are in a multitude of industrial applications from steel rolling mills to computer-aided design.

Intelligent knowledge based systems may be considered as an adjunct to secondary surveillance, particularly for condition monitoring.

The man/machine interface will benefit from advances in graphics packages, with colour and speed of presentation compatible with the operator's needs. The applicability of touch sensitive displays and buttons in lieu of levers is worthy of attention.

In due course distributed control and surveillance packages around the ship will be interconnected via a true bus structure with the capability of ship control being exercised at any access point from bridge wings to steering flats. However, such a bus expansion must not reduce the reliability of the system as a whole. A fundamental fact concerning data rates applicable to machinery control and surveillance is that they are less than one tenth of those of combat systems but the acceptable error rate is considered more stringent by a factor of at least 1000.

It is my assertion that the sensible application of digital technology will economically achieve the goal of efficient control and surveillance of the propulsion and auxiliary package with a considerable saving in manpower and cost.

References

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