MACHINERY CONTROL AND SURVEILLANCE

RECENT ACHIEVEMENTS AND FUTURE AIMS

BY

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ABSTRACT

Digital Machinery Control and Surveillance systems are now in operation in the Type 23, the Single Role Mine Hunter, the AOR and the BULLDOG Class update, with digital surveillance systems in VANGUARD and UPHOLDER Class submarines. The appropriate shore trainers are coming in to use. Combination of individual systems into Integrated Platform Management Systems and the use of Intelligent Knowledge Based Systems are being considered.

Introduction

At the two previous ship control systems symposia[1,2] I gave brief reviews of progress along the technical pathway which has taken Machinery Controls and Surveillance (MCAS) technology from the analogue electronics applications of the 1970s to the exploratory applications of digital systems on shore and then to the decision in 1982 to go to a more embracing digital system for the Type 23 frigate and later the Single Role Mine Hunter.

This trend is continuing and all new design ships will utilize digital technology to a greater extent than previously. However, caution in the world of controls for ships is such that we have not yet reached the 'fly by Wire' philosophy of the aircraft world.

Nevertheless digital technology is here and will occupy centre stage for some years to come, as its advantages and disadvantages are completely understood by its practitioners and its applications permeate the control and surveillance needs of the whole ship.

Integrated Platform Management Systems are now beginning to be applied at the outset to new ship designs, to capitalize upon the system ability to manage, control and survey the whole of the platform facilities with reduced manpower yet increased efficiency. They will, in turn, require the consideration of human factors involved in such a management strategy. Cognitive overload could be relieved by the judicious application of Expert Systems assistance which uses the man to his maximum ability without reaching his capability limit.

Achievements

Type 22, Batch III

Within the last three years, the Batch III of the Type 22 frigates has been completed and totally accepted into the Royal Navy. This batch of ships was the last to use analogue technology for the Machinery Control and Surveillance System, being procured before digital systems had reached sufficient confidence in development. It can be recorded that the system provided by HSDE has passed all its tests and trials with flying colours and does not figure in reports of design shortcomings from sea.

Type 23

Turning now to the Type 23 frigate, H.M.S. *Norfolk* is the first of class built by Yarrow Shipbuilders Ltd and as I write has completed many trials of her programme. The digital Machinery Control and Surveillance System, based on the Vosper Thornycroft Controls D86, has performed very satisfactorily with few errors of design being exposed during the programme.

This satisfactory state of affairs can in part be attributed to the shore test and assessment undertaken by the Admiralty Engineering Laboratory at West Drayton[3]. Such shore assessment is essential for this and future Machinery Control and Surveillance Systems, as their complexity and essentiality to ship performance increase to at least equal that of a Weapons System. Shore-based test and evaluations combined with a permanent reference set has been the norm for Weapon Systems and it is essential that reference sets must be established for Machinery Control and Surveillance Systems for these new classes of ship. This requirement is being written into the Staff Requirements for new designs, and I trust its essentiality is recognized for sound ship procurement and support. The MCAS System is set to grow into Integrated Platform Management System and, even more than the present designs, it will form the bond between the innumerable individual items of equipment which make up the whole platform system.

Single Role Mine Hunter

The second class of ship now being proven is the Single Role Mine Hunter built by Vosper Thornycroft (UK), the first of class being H.M.S. *Sandown*. Again the Machinery Control and Surveillance System based on the VTC D86 has performed extremely well.

Briefly the MCAS System can be controlled from the quartermaster's console on the bridge, from extensions on the bridge wings, from the quarter deck and from the AIO. The outstanding ability to hover, change direction and achieve crash stops is attributable to the Voith Schneider propulsors under the control and surveillance of this installed system. Once again this control console and associated digital electronics was given an exhaustive on-shore assessment at Cambridge Consultants Ltd.

Submarines

Two other applications of the D86 digital system nearing completion of trials are those for the surveillance systems in H.M.S. *Vanguard* and the Type 2400 submarine H.M.S. *Upholder*. Although not for discussion at this symposium these figure in the support activity being set up for the surface ships D86 systems.

This support activity is itself worthy of mention as its aim is to provide common configuration control of the many hundred electrical boards which will be in service in due course. Information Technology attributes will be used to the full in order to minimize manpower whilst achieving maximum control over modifications of hardware and software and instant access to each particular ship fit record.

AOR

The comprehensive MCAS system for the Auxiliary Oiler and Replenishment Ship (AOR), the first of which is R.F.A. *Fort Victoria*, is based upon the HSDE D6000 system and incorporates the surveillance of 4000 points including the cargo and ballast systems [4, 5].

The system configuration has distributed control and surveillance by location to minimize cabling between plant and outstations, with the outstations located to share evenly as far as possible the signal inputs and outputs. For critical services, back-up is provided by dedicated direct circuits.

A feature of the system is the multiple control positions, provided for example bridge, Machinery Control Room, Damage Control HQ, etc.

'Bulldog' Class Survey Vessels

The above applications of digital systems have all been to new design ships. However the first of an existing class of 18-year-old coastal survey vessels, H.M.S. *Bulldog*, has just completed her acceptance trials of an HSDE designed and supplied control system based on their D5000 8 bit system.

This new propulsion control system[6] is designed to co-ordinate the propulsion machinery to provide the desired ship performance while preventing unsafe operation and without exceeding the machinery stress limitations. To achieve this, the system provides automatic control of the two shafts with their associated diesel engines and controllable pitch propellers. The automatic control functions include the clutches and shaft brakes in addition to providing scheduled control of engines and propeller pitch. The system provides an approximately linear relationship between power control lever position and ship's speed. Fully automatic control is available from the MCR and bridge with extensions to the bridge wings.

The system provides automatic load sharing between the two engines on each shaft and additional facilities for monitoring of machinery status, and warning of abnormal conditions, combined with a diagnostic capability via the maintainers' system monitoring panel.

This example illustrates that incorporation of new technology into an older ship is feasible and has improved performance in particular, for this ship class, in the Man Machine Interface and the propulsion power balance.

Training

As I stated at the 8th Symposium[2] the introduction of digital control systems into the Royal Navy was a major technological step forward offering control systems which should be more powerful, flexible and easier to operate, maintain and support. We have now reached the point at which they are accepted into ships at sea and the ability of the ships' staffs to operate and maintain the system has high visibility.

The Type 23 Operator and Maintainer Trainer[7] was successfully commissioned at H.M.S. *Sultan* in January 1989 and has been in regular use since, both to train ship's personnel and others involved in setting to work the follow-on ships.

In addition to the full MCAS panel the Type 23 Trainer incorporates simulated local control panels for the major propulsion and electrical equipments. Furthermore, the auxiliary systems can be operated via interactive VDUs thus allowing full recovery action to be taken for all major machinery breakdown exercises.

The Single Role Mine Hunter operator and Maintainer Trainer is in the course of procurement, the contract being let on Rediffusion Ltd in September 1989 with a completion date of April 1991. This trainer will offer a fully integrated training environment within a single classroom. The full-scale machinery control console and switchboard drive a complete computer simulation of the machinery and electrical equipment. Three work stations can be configured to act as interactive local control panels for the Voith Schneider propulsors, bow thrusters and main engines. These work stations can also provide computer-based training for all main and auxilary machinery and systems and maintenance such as fault-finding training for the D86 equipment on board the SRMH.

In support of both of these trainers is the installation of another, the Common D86 Maintainer Trainer[8], on which the Navy maintainers obtain their basic understanding of the units which they will meet in the many controls and surveillance systems installed in the Royal Navy.

Supplementary Systems

The life span of ships and electronic devices is markedly different, and existing ship classes are often using technology 15 years old. Such installations can be adequate however; often a marked improvement in plant management can be achieved by replacing existing control and surveillance equipment by today's model. Two examples in process of being introduced are:

(*a*) The Teddington Mark 6 local control and surveillance panel uses digital technology and is markedly smaller than the analogue item it replaces, which is now becoming unsupportable. It is used for the control and surveillance of diesel generators, compressors, refrigeration plants, etc.

(*b*) The Decca Isis 250 series is progressively replacing the Type 300 as it becomes unmaintainable. The 250 uses digital technology and colour VDUs to provide an extensive surveillance system with a control option if desired.

Future Aims and Applications

Digital technology in ships now entering service has essentially been cautious, by the very nature of the role required and the need for proof of reliability of this new, to the Navy, technology. The surveillance mode has advanced with more speed and the benefits of remote and comprehensive surveillance have been welcomed, together with the reduction in manning which has resulted.

Most effort in ship control systems designed in recent years has been expended on the consideration of interactive sub-systems such as propulsion, steering, stabilization, and electrical power generation, as though they were independent entities. The integration of these individual systems into an Integrated Platform Management System (IPMS) is being considered for ships designed now.

Such a system will access a very large quantity of surveillance information and this in turn will require management changes. One possible solution is the use of an Expert System or Intelligent Knowledge Based System (IKBS) to process the incoming surveillance and to prioritorize the alarms and warnings so that the watchkeeper is not overwhelmed by the flood of information which could occur under fault or action damage condition.

The rapid increase in the size of control and surveillance systems, particularly the latter, is showing the limitations of the serial Von Neumann architectural approach. I believe that parallel processing using transputers combined with the traditional approach will be necessary to cope successfully with the increased demands associated with IPMS or any IKBS support designed into future ship systems.

A particular area of surveillance which may benefit from the application of digital technology is that of damage control and surveillance, as developments in this area have generally lagged behind those in machinery control. For example, fire alarms appear on one panel with flood alarms appearing elsewhere, similarly other information is held on a variety of stateboards and in books. A much more efficient presentation of information is needed. The latest damage surveillance system to enter service is that of the Type 23 frigates where fire, flood, and door and hatch status all appear on one alarm panel and similar equipments are being produced for our latest submarines. A new system has also been developed for the Type 23 frigate to provide an efficient presentation of other items of important data. Further developments using smart sensors, distributed processing and expert systems are also being investigated against the background of reduced manning.

Conclusions

During the last three years considerable effort by industry and MOD has brought the paper designs of digital control and surveillance into reality. Ships are now at sea using the early 1980 designs in the real environment and registering considerable success in reducing manning and improving power management. However there is considerable stretch potential yet to be exploited, and present and future specifications and resulting designs should capitalize upon the efficient management of the total platform.

Platform system engineering must be acknowledged as an essential ingredient in the design of future warships and digital technology is one tool in the achievement of this aim.

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