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THE VERSATILE CONSOLE CONCEPT

Part 1—An Introduction to the Principles and Design Processes of the Versatile Console System used in Warships for the Presentation of Electronic Controls Indications and Communications

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SYNOPSIS

The Versatile Console System (VCS) is a system of consoles and deckhead or bulkhead mounted assemblies, together with a standard range of modular plug-in units, which gives the operator an ergonomic presentation of controls and indications. VCS is currently used primarily in warships but the general principles have possibilities of wider application in other types of vessels and land installations.

Benefits offered by the method of console construction and the standardised range of units are, ship system and compartment design flexibility, rationalisation of equipment designs, ease of shipboard installation, and reduced maintenance effort. The use of VCS also encourages a systematic and disciplined approach tc the management of warship design and upkeep tasks.

INTRODUCTION

The Versatile Console System consists of consoles, overhead assemblies and associated units of modular construction, which together with the seating arrangements and the operator himself provides an integrated approach to help overcome the many man/machine interface problems which occur in a warship. The system is not new and does not employ any revolutionary principles, but has been tried and proven over the past 15 years.

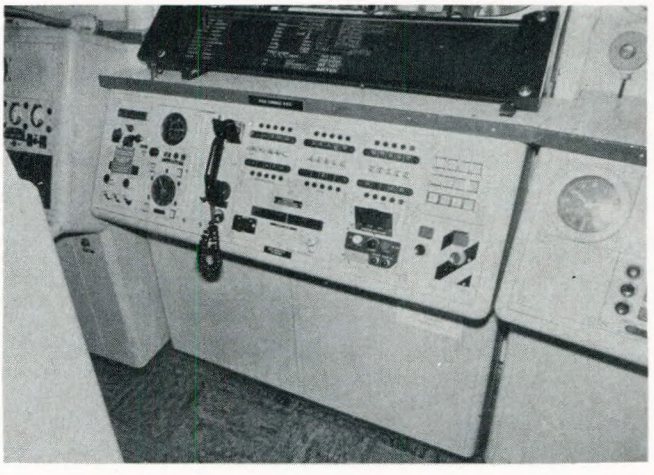

FIG.1. TYPICAL V.C.S. CONSOLE.

Fig 1 is an example of a console for a ship presently under construction, and Figs 2 and 3 show the overall layout of equipments on the Bridges of Frigates before and after the adoption of VCS.

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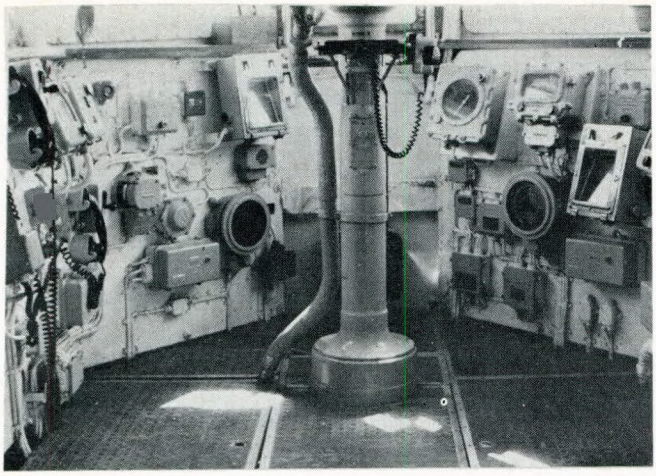


FIG. 2. FRIGATE BRIDGE BEFORE ADOPTION OF V.C.S.

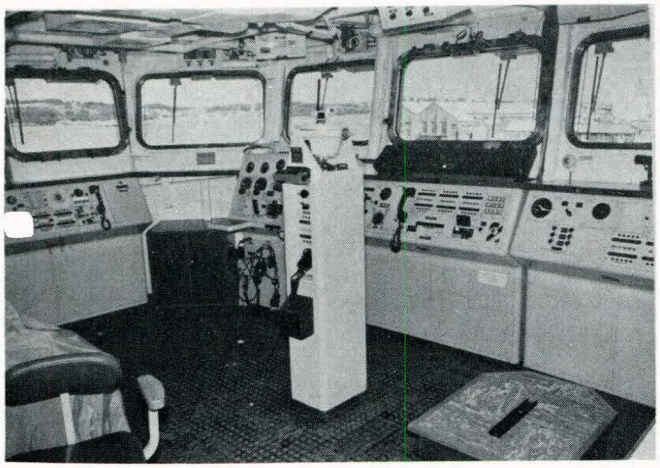


FIG. 3. FRIGATE BRIDGE WITH V.C.S. FITTED.

The purpose of this paper is to describe briefly the main features of VCS, the reasons for its introduction, and the associated procedures which are followed to completion of console sketch designs. The following paper by Messrs Aish & Co covers the production and quality assurance methods employed during manufacture; and the paper by Vosper Thornycroft, Controls Division, describes the various ship applications, installation and setting-to-work of the system.

DESIGN FEATURES

The system comprises consoles and assemblies which incorporate within their frameworks numbers of "boxes" into which are plugged various sizes and types of unit. A variety of shapes of consoles and assemblies may be constructed from the standard range of aluminium cast corners, brackets and other components together with main frame and cross members. They range from the simple boxes of overhead assemblies, Fig 4, to large consoles with desk sections, overhang and wing panels.

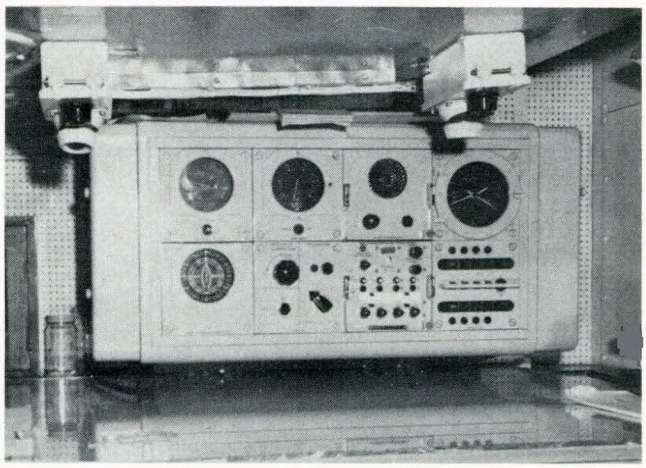
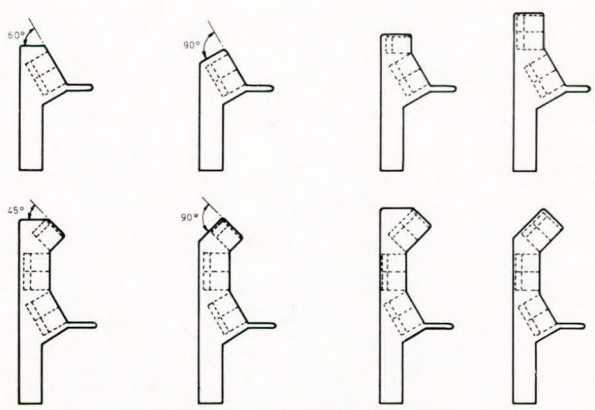


FIG. 4. TYPICAL V.C.S. OVERHEAD ASSEMBLY.

Consoles may be designed for sitting, or for sitting and standing, see Fig 5.



TYPICAL VARIATIONS OF SHAPE USING A 60° SLOPE

FIG. 5. EXAMPLES OF RANGE OF CONSOLE SHAPES.

The basic unit size is designated 1 x 1 which has a front panel size of 152mm x 152mm (6in x 6in). The majority of individual units are of the 1 x 1 cell size, but many are multiples, up to the largest size of 3 x 3. Large unit sizes are not however preferred, mainly because of the need to ensure adequate performance under shock conditions.

Three types of framework construction can be used, namely:

20 series
30 series
1000 series

The 20 series is a light framework used for lower levels of shock protection, and the 30 series is a heavier frame construction used for shock levels up to 30g vertical acceleration. The 1000 series is a special light weight method of construction which takes up a smaller space than the other methods and is capable of withstanding 70g vertical acceleration. It may be used for small assemblies not exceeding two basic size units either horizontally or vertically.

The method of construction used for VCS makes it unsuitable for use on weatherdecks without additional cover or protection, or for siting in hazardous areas.

Almost any types of controls, indications or circuitry may be built into the available sizes of VCS unit and to date over 530 different types have been manufactured. Fig 6 shows a typical example.

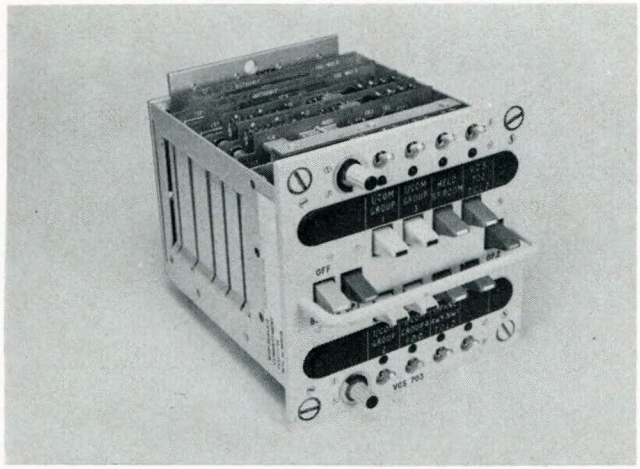


FIG. 6. TYPICAL V.C.S. 1×1 UNIT.

To avoid impairing night vision performance, indication and tally strip illumination light levels for units sited on the Bridge or in the Operations Room have a dimming capability provided by a separate VCS Dimmer Unit.

The individual units are secured into the box cells of the consoles by four corner threaded screws, and the electrical connections are made by plugs and sockets which are automatically mated as the units are inserted. When units are removed they are therefore electrically dead and have no trailing connections.

Wiring looms connect from the back of the plugs to the terminal chamber which is usually sited at the base of the console. The ship's cabling normally enters through the base of the console, and connections are made to taper pin terminal blocks or screw terminal blocks.

BACKGROUND HISTORY AND BASIC PHILOSOPHY

The concept of the Versatile Console System was proposed as a result of the findings of a study undertaken in 1959. The study was initiated because it had become apparent that existing arrangements, particularly for bridges and Operational Spaces, consisted of a wide variety of individual equipments which were not being fully integrated to take account of the total user requirements. Insufficient attention was given to ergonomic considerations when compartment layouts were developed, and to the rationalisation of equipment designs.

The main aims of the design study were therefore to achieve the following:

a. an ergonomically efficient presentation of controls and indications for the operator

b. flexibility of compartment layout and systems design

c. rationalisation of equipment designs

d. easier shipboard installation

e. improvements in maintenance and logistics effort

Ergonomic Considerations

The study for the fundamental physical design of the consoles, assemblies and units made use of standard anthropometric data for

male operators. From the beginning it was considered essential that the operator, his seat, the desk section, and the controls and indications need to be treated as a single entity. The operator must be able to use controls, see displays, and have adequate body support provided by the seat and the console.

Design parameters are based on catering for a 90% range of naval male personnel, ie from what is known as a 5% man up to a 95% man. A 5% naval man has a height of 1647mm (5ft 5ins) and a weight of 54.6Kg (8st 81bs); whereas a 95% naval man has a height of 1842mm (6ft ½in) and a weight of 79.7Kg (12st 21b). These statistics are such that 5% of naval male personnel have heights and weights less than those for the 5% man, and 5% have heights and weights greater than those of the 95% man. Comprehensive data for a whole range of body measurements is available in standard publications. It should be noted that although body measurements are generally proportional, a 5% man may for example have a 95% mans waist measurement.

Three basic reference systems were considered for the console seating configuration. These were:

a. fixed foot level with adjustable seat height.

b. fixed eye level with adjustable seat height and a foot rest.

c. fixed seat level with adjustable foot rest.

Option b. above is best as far as the operator is concerned but excessive console space has to be provided to accommodate the legs of the tall man. The compromise of a fixed seat level with a three-position footrest was adopted, which means that the seated eye level height varies by about 11.2mm (4.4in). Two seat designs, which match the console dimensions, are provided - one for the sitting arrangement and another for a dual sitting or standing requirement.

The basic brick size of the modular units was chosen as not so small that the console structure would be too complicated and expensive, and not too large that a heavy structure was needed.

A study of the range of equipment designs existing prior to the introduction of VCS indicated the most useful unit size to be in the range 140mm (5½in) to 200mm (8in). A sub-division of the recommended console sizes, which were based upon authropometric data, led to a basic unit size of 152mm (6in) x 152mm (6in) being adopted.

Design Flexibility

The console system design is required to provide a degree of flexibility to cater for changing operational roles and requirements. It can take up to 10 years from the stage of user requirements being specified to the time that compartment and system arrangements are tried out in earnest during work-up at sea. Further changes in operational requirements also occur throughout the life of a warship, and practical and economic considerations place severe constraints on the number of alterations which can be undertaken. A system design, therefore, which provides a degree of flexibility and versatility enables limited changes to be made outside of refit periods.

Rationalisation of System and Equipment Designs

The different disciplines and trades employed in the shipbuilding industry make integration of ship systems difficult, and a design procedure which encourages all parties to perform the correct functions is essential. Equipment design by different departments can also lead to a proliferation of equipment types and variants. The various ship, surface and underwater weapons departments which sponsor system designs produce equipments in the VCS form where appropriate, and common standards of VCS engineering ensure interchangeability and console design flexibility.

Consolisation and modular construction are themselves both concepts which are used to advantage in many applications but their effectiveness is improved when a standardised system is used over which a central control is exercised.

By keeping a comprehensive central register of all units, a check can be made that duplication and overlap of equipment types are kept to a minimum. It is a design aim that new unit developments should fulfill a wide range of applications. It is possible, for example, with recent improvements in component technology that a design developed to meet a new requirement can also be used to supersede two or three existing units. However, the benefits of reduced documentation and support have to be balanced against the possible high additional unit costs resulting from overcomplicated designs.

Shipboard Installation

In addition to the benefits to the operator and the designer of a "consolised" arrangement of standard plug-in units, there are also advantages to the installer and to the maintainer. The installation of electrical equipments in the form of consoles and assemblies is generally easier and cheaper than with a large collection of individual equipments. Mounting arrangements are simplified and overall space and weight savings can be made. Also cabling is brought to centralised locations and interconnection between individual units is made in the console wiring instead of cabling run around the compartment. The use of external Junction Boxes can be minimised by utilising terminal blocks within the consoles. System modifications can therefore often be accomplished within the console wiring, avoiding the more difficult and costly changes to ship's cabling.

Empty consoles and assemblies may be installed and cabled early in the build programme and the advantages this gives a shipbuilder are dealt with in more detail in the Vosper Thornycroft paper.

Maintenance and Logistic Support

The modular, plug-in construction method provides a means of quick replacement of defective units which is very valuable under action or emergency conditions. Units of the same type are fully interchangeable and routine maintenance is easily managed by replacement of units by spares while the defective item can be repaired in maintenance rooms where proper facilities are available.

The overall standardisation of VCS unit designs also allows the types and numbers of spares holdings to be maintained at reasonably low levels.

CONSOLE DESIGN PROCEDURE

The design of the VCS consoles and assemblies for a warship constitutes an important part of the overall ship design process.

When compartment layouts and ship system drawings are available, the preliminary VCS design can start to be developed. For a particular compartment the space available for consoles and assemblies is established by examination of the compartment layout drawing, and similarly, from examination of the system drawings the user facilities which have to be provided in the form of VCS units are determined. The two basic factors of space available, and facilities required are often, of course, interdependent and one may have to be changed by constraints imposed by the other.

When the space allowance for a console, and the facilities it has to contain, have been agreed, the VCS design group select a suitable type of console and prepare sketch design drawings. The sketch designs are produced in isometric drawing form, which it has been found are most readily appreciated by the users. They show the outline and angles of the main surfaces of the console, the VCS units fitted, overall dimensions, fixing centres and weight, together with the ancillary fittings and attachments.

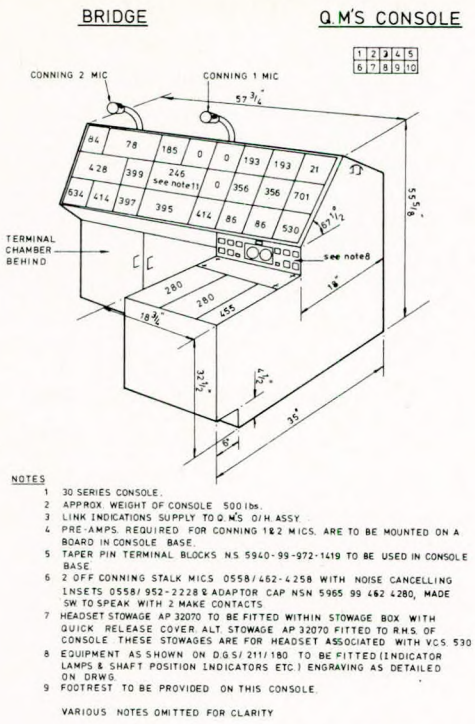


FIG.7. CONSOLE SKETCH DESIGN.

Fig 7 shows a sketch design of a console for a ship presently being built. The design is based either upon the overall dimensions of a similar console previously fitted or is developed from basic principles using authropometic data. See Fig 8.

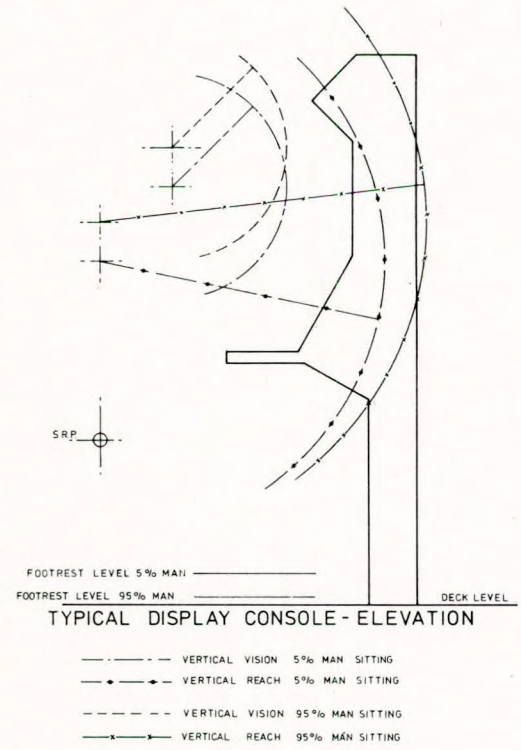


FIG.8. CONSOLE ELEVATION.

Practical engineering details such as methods of mounting and the provision of ample space for cable entries and terminal chambers have to be considered at this stage.

When the overall size, shape, shock requirements and mounting and cable entry arrangements for the console have been established and the units and spare unit spaces agreed, the next step is to layout the positions of the units in the console. It is clearly necessary to have some knowledge of the systems, and the functions of the controls and indications which are fitted. Information on:

a. frequency of use.

b. accuracy and speed of operation required.

c. effect on system of delay or error.

d. association with other displays and controls.

has to be considered. The following are some of the principles and guidelines which are followed when siting individual units:

a. the most important and most often used controls are positioned within easiest reach.

b. associated controls are grouped together.

c. indicator or dial displays are placed with, and above, their associated controls.

d. steering units are sited on the centre line of the console with tape repeaters directly above steering units.

e. important controls are preferred to be used by the right hand and take a larger share of the task load.

f. headset sockets (which are normally ancillaries and not VCS units proper) are located so that the leads do not trail

across the face of the console.

The above requirements invariably lead to conflicting claims for the prime positions and some degree of compromise has to be accepted. This is only done however after agreement with system sponsors as well as user interests.

Often final agreement can be reached only at a mock-up inspection. The more important compartments of a warship are mocked-up in detail in wood and hardboard, see Fig 9, and these are used as the basic tool for finalisation of compartment layouts and VCS console sketch designs.

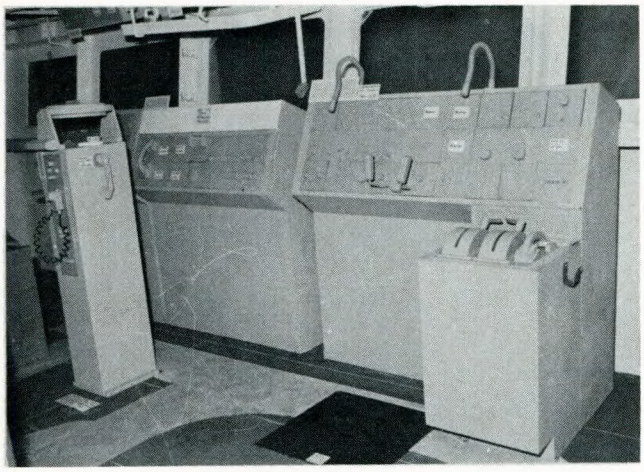


FIG. 9. MOCK UP OF NEW CONSTRUCTION BRIDGE CONSOLES.

Wherever possible units from the existing range are selected but if there is no suitable unit already in production, a new design has to be developed by the system sponsor or the VCS Design Group.

When sketch designs have been agreed the console wiring schedules are produced. The VCS unit connection details, and system drawings and specifications have to be made available to whoever is producing the wiring schedules, and close liaison maintained with system sponsors. With the Sketch Designs, wiring schedules and the VCS engineering standards, sufficient information is at hand to commence the detailed manufacturing drawings. Production of individual VCS units may proceed independently of consoles and assemblies, and are often produced by several manufacturers.

FUTURE DEVELOPMENTS OF THE SYSTEM

Although no changes in the basic concepts of VCS are planned certain detail aspects are being considered. These include making a better use of the space available within the consoles, providing space saving and greater versatility by the introduction of a smaller size unit, and the possible implications of metrication.

Use is already made of space inside consoles for the accommodation of power units, transformers and some other electrical components; and also cupboards, bookshelves and racking are provided where appropriate. It is considered that better use of consoles and assemblies could be made by fitting a wider range of electrical equipments, even those not requiring operator controls or indications. It is important that any components or sub-assemblies should be easily removable from consoles - either in the form of blank faced units or as complete assemblies wired with connectors.

Continuing advances in electronics and component technology, and the increasing demand for space limitation in warships have led to reconsideration of the size of the smallest basic unit. Electronic circuitry usually takes the form of Printed Wiring Boards upon which are mounted the various components. A Unit size of 6in x 2in lends itself readily to the mounting of such boards and also allows a few operator controls and indications to be fitted.

The cost of installation and the space taken up by electric cabling has caused serious study of the possible advantages offered by the techniques of multiplexing of electric signals (ie the use of a single conductor pair to carry many individual circuits) and the use of fibre optic links. The Versatile Console System is ideally suited to make the best use of these opportunities as equipments are already concentrated within consoles at the centres of maximum information flow.

CONCLUSIONS

VCS does not provide a complete answer to the varied and complex ship control problems, but it gives considerable improvements over previous arrangements and has been a general success. It has not only tidied up the layout of equipments within ship compartments, but has allowed the users to perform their tasks more efficiently.

Ease of maintenance and reduced logistics are also apparent, but the main benefits to the management of warship design and upkeep have been the disciplined approach to design procedures and rationalisation of equipment types which use of the system encourages.

No changes are envisaged in the basic concept of VCS as it has proved to have a wide and general acceptance by the users (including several navies), and by ship system design authorities and warship builders.

The above views expressed are those of the author and do not necessarily represent those of the Ministry of Defence.