Part 3—Application of the Versatile Console System for Monitoring Controls and other Ship Control and Indication Purposes

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Synopsis

Applications of the Versatile Console System by a major warship builder are described, with particular reference to applications for machinery controls and other control and indication purposes in a typical modern warship. A shipbuilder's approach to incorporating the system in new ship designs is outlined. Adaptions of the VCS are also described. Certain recommendations are made regarding the implementation of VCS.

Introduction

It is well known that modern warships, with their multiple advanced automated systems for functions such as weapons control, action information, navigation, threat evaluation, control of combined propulsion schemes and electrical distribution control, pose severe difficulties to shipbuilders. In particular, packaging the equipment and presenting operators with display and control elements in a logical easily assimilated form, have proved increasingly difficult. The 'piecemeal' approach is no longer acceptable and the various systems must be installed in an integrated fashion which at the same time permits ease of operation and maintenance, and is readily installed, simple to change if necessary, robust, compact and protected to the requirements of the appropriate defence standard specifications.

The previous papers have already dealt with how a system intended to meet these needs - the Versatile Console System - came into being and have described how it is designed and built. It has been seen that the keynotes of the system are flexibility in operation - including the ability to design consoles of an overall shape appropriate to the application - plus a degree of across-the-fleet standardisation so that fleet support and spares holdings can be rationalised.

This paper, describes in outline how Vosper Thornycroft has applied the VCS concept to its modern warships, not only those of our own navy but for overseas forces. It concludes by making, from a shipbuilder's experience, certain recommendations about how VCS may be implemented.

Basis of experience

Experience with fast frigates, corvettes, patrol craft, mine countermeasure vessels and hovercraft have provided the basis for a deep understanding of the total design needs of modern warships. More than a decade ago it was noted that the 'systems' proportion of a warship was increasing dramatically and that sophistication of control, display and communication elements demanded a new approach to their presentation to operators. At a time when

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the need for some adaptable, operator-orientated modular system became pressing, the VCS was developed - fortunately for everybody concerned. The system has since been widely adopted - not least to house control systems for the advanced combined propulsion schemes essential to modern warships - sometimes in conjunction with other modular and 'adapted VCS' systems where, perhaps, the full benefits of VCS are not required.

Table 1 is a list of ships for which the organisation with which the writer is associated has supplied VCS consoles. The ships are all frigates.

Table 1

CLASS	NO OF SHIPS	BUILT
Rothesay (Royal Navy)	4	1968-69
VT Mark 5	4	1968-72
VT Mark 7	1	1972
Type 21 (Royal Navy)	8	1968-74
VT Mark 10	6	1973-76
Type 22 (Royal Navy)	2 (to date)	1975

Building VCS into a Ship

The shipbuilder's approach to incorporating VCS in any new ship is, in essence, as follows:

1. An initial ship specification is drawn up and offered to the customer for comment. VCS modules may be 'written in' at this stage; it is usually not difficult to convince a customer that VCS is a cost-effective way to reduce space requirements while achieving the best solution operationally and ergonomically to the problem of control and display presentation.
2. Once the main systems and machinery configuration for the ship have been decided, a detailed system design is produced. At this stage, the shipbuilder's knowledge of operational procedure is of paramount importance in collating and interpreting a great deal of information from a number of sources. From a consideration of the tasks to be performed, the network and interactive requirements (eg: who should communicate with whom) and the equipment characteristics, the designers decide how many control/display stations there should be, the disposition of equipment at each and hence, what VCS modules will be required.
3. Where possible, the shipbuilder will select modules from the list of more than five hundred standard units already included in the Ministry's VCS Register. Where no suitable unit is already available, the shipbuilder may design and build one himself; this can be made into a system 'standard' where its use on several ships is anticipated, by applying to the Ministry of Defence.
4. Working closely with other departments and outside organisations, the electrical engineering department - which has overall VCS responsibility - decides the module grouping, taking into account the number of operators, the various human engineering factors, the non VCS content (if any), maintenance, and cost-effectiveness; however, in every case the prime task is to ensure that the control and display elements are presented to the appropriate operator in a clear, rational and easily interpreted way so that control under action conditions may be quick and precise. VCS consoles may be specified for various points in the ship but are most likely to be found on the Bridge, in the Ship Control Centre (SCC) and in the main Operations Room - all areas where the highest 'system' concentrations are experienced.

   Experience shows that time spent in arriving at an optimum layout is well worthwhile, and wooden mock-ups are a major aid to this process.
5. Another area where mock-ups help is in determining console shape and layout. In this respect it is found that the latitude allowed by VCS in making consoles to any shape or size required for a given location, subject to the need to accommodate standard modules of 6" x 6" x 6" or multiples of these dimensions, is invaluable.

   Figure 1 shows a mock-up set, this one representing the bridge units on a frigate.
6. After final mock-up approval has been agreed with the customer, detailed console design is carried out. The drawing office prepares sufficient drawings to enable the multibox assemblies to be produced and wired. The shipbuilder's approach is to economise on drawing office time wherever this is possible without prejudicing quality or production efficiency; for example, wiring schedules can be perfectly adequate without the need for wiring diagrams, and in many cases find parts lists suffice without detailed outline and

Fig: 1

mechanical drawings.

7. Materials and components which represent special customer requirements are ordered as soon as possible, all standard material comes from stock.
8. Multibox frameworks, cabinets and terminal grids are produced, assembled and wired internally.
9. After factory testing, the units are subjected to customer acceptance procedures.
10. At the appropriate stage of ship construction, consoles are installed and wired, making use of the facility VCS offers to completely install and pre-wire consoles before the equipment modules are available. This has the further advantage that risk of damage to expensive equipment during installation is minimal.
11. When received, from Ministry sources, subcontractors, or the shipbuilder's engineering workshops, modules are tested, spigot positions checked and the modules introduced into the console.
12. Consoles are fully system tested as soon as the ship's cabling is sufficiently advanced.
13. Final operational evaluation and testing is carried out during ship trials and commissioning. Experience shows that any changes resulting are relatively easily accommodated by the VCS concept, especially if the shipbuilder adopts a generous attitude to wiring initially, for example, incorporating spare wiring to the connectors.

Applications of VCS on warships

Let us now consider in more detail the VCS content of a particular Class, in this case the Mark 10 design frigate. Figure 2 shows the enclosed Bridge position; the various consoles are seen at the forward perimeter, with a typical deckhead mounting, and the free standing pelorus unit near the centre. The consoles visible are, from left to right - Bosun's Mate; QM's Engine Control; OOW and QM's Steering; Captain's Console and Communications (on its own) Pelorus Stand.

Fig: 2

Also extensively equipped with VCS units are the Operations Room, Ship Control Centre, and various other locations throughout the ship. Total number of VCS units per ship amounts to nearly 60. Equipment on the Bridge is largely concerned with command, steering, navigating, engine and electrical systems; that in the Operation Room with fighting the ship; in the SCC with providing an alternative central control facility for many of the Bridge functions and fulfilling ship environment protection needs; and elsewhere in the ship, with miscellaneous functions.

As an example of one of the VCS layouts, part of the Officer of the Watch and Quartermaster's Console (steering section) is illustrated in Figure 3. The console can be seen at third from left in Figure 2.

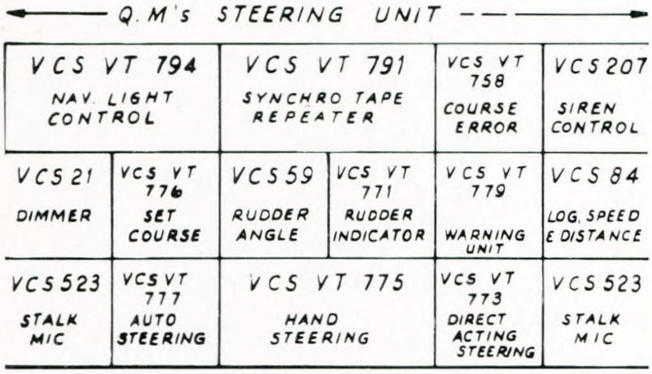

Fig: 3 - Quartermaster's Steering Console

Adaptations of the VCS concept

As already mentioned, the shipbuilder has not adapted VCS universally in vessels built, even for display communication and control elements. Even in the Mark 10 frigate Operations Room, representing one of the most concentrated equipment environments, VCS accounts only for perhaps 50% of the units, and it may have been noticed in the Ship Control Centre on the Mark 10 the VCS content is relatively small. This is because although VCS offers an extremely flexible modular system for the rational setting-out of operator facilities, in some cases other factors take precedence.

One instance is the electrical distribution desk in the SCC. Here, it was decided that minimum size and weight, and a mimic presentation of the electrical system, had priority over the advantages of VCS. The latter, being a modular system, does not necessarily provide the most compact console, nor does it lend itself to mimic display. Accordingly, the shipbuilder adopted a more traditional, non-modular, console design.

A slightly different case in the SCC is that of the main console housing the controls for the Propulsion Machinery Remote Control System. Here, cost was the governing factor; although the machinery control elements on the Bridge are VCS-based, building the more comprehensive facility in the SCC entirely on the same basis would have involved significant cost penalties in adapting an existing design. However, the console, fabricated and welded by the shipbuilder, is an example of 'adapted VCS', in that the multibox technique has been used successfully to house the electronic control modules. Front panels are standard VCS module blanks, either 6" x 6" x 6" or 12" x 6" and have matching rear panels fitted with standard connectors.

A typical module, the engine changeover logic module, is shown in Figure 4 and 5. The printed circuit boards, each associated with a particular control function, are housed in the unit as shown. The 'mother board' technique is used each functionally linked with several 'daughter boards'.

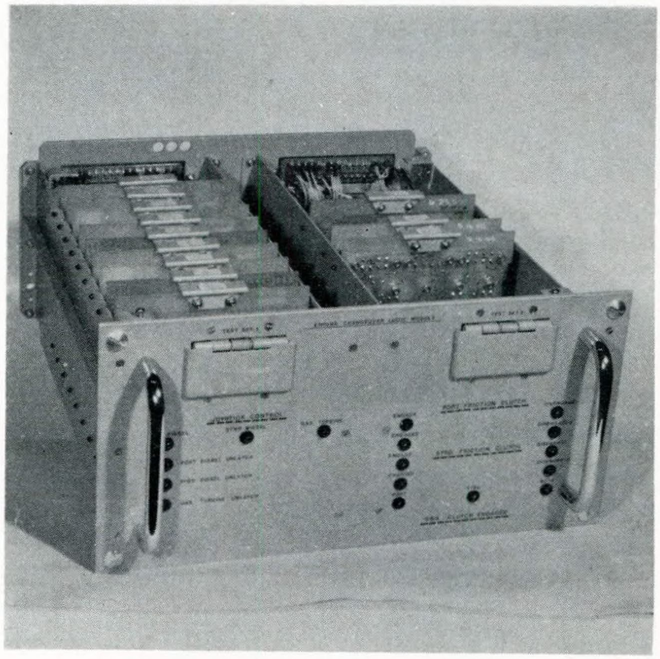

Fig: 4

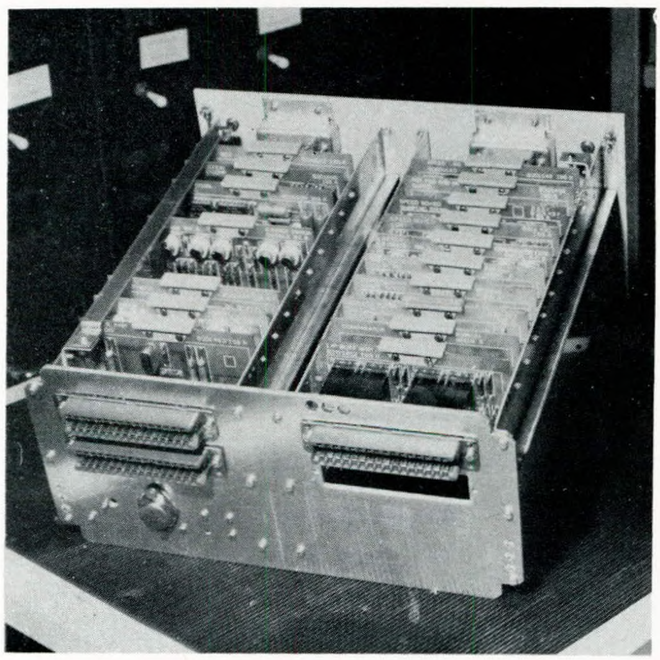

Fig: 5

Each module has its own multibox, and standard front panel fastening; cabling from the rear of the multibox is taken to the base of the console. In the application, standard VCS ship wiring terminal blocks are not used; instead plug-in type terminals are employed which allow the complete multibox assembly to be installed afterwards if necessary. Important requirements were that it should be possible to test the complete propulsion machinery control system prior to its installation and that the console should be able to be installed before the multibox assembly was available. Figure 6 shows a multibox extension unit, which allows an individual module to be withdrawn and checked 'on line' using its own associated power supply unit.

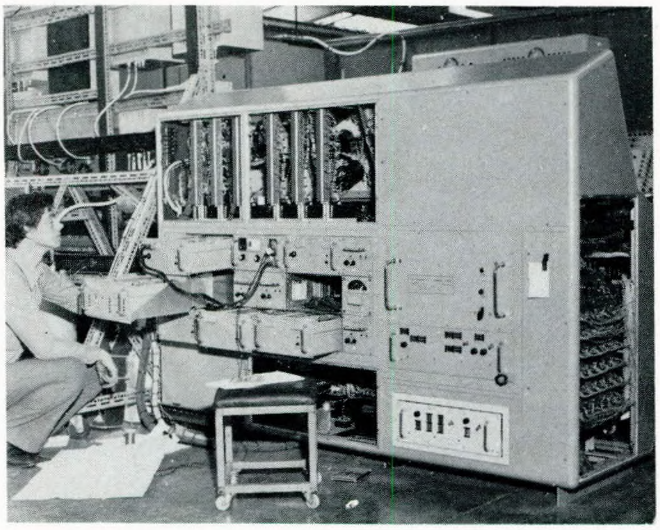

Fig: 6

Figure 7 shows the complete propulsion machinery control desk in the SCC of the Mark 10 frigate. The control desk contains mandatory instruments for the control of the propulsion engines. The LH and RH panels are for gas turbine indication and the centre panel is for instruments for diesel propulsion engines. On the desk top is the Engine Order Telegraph and control levers which control both gas turbine and diesel propulsion engines.

A further example of the adaptation of VCS principles appears in Figure 8 showing the basic framework for a console intended for a submarine. This console designed to withstand high shock conditions, will include several standard VCS modules. An important requirement was that the console should be able to be passed in complete sections

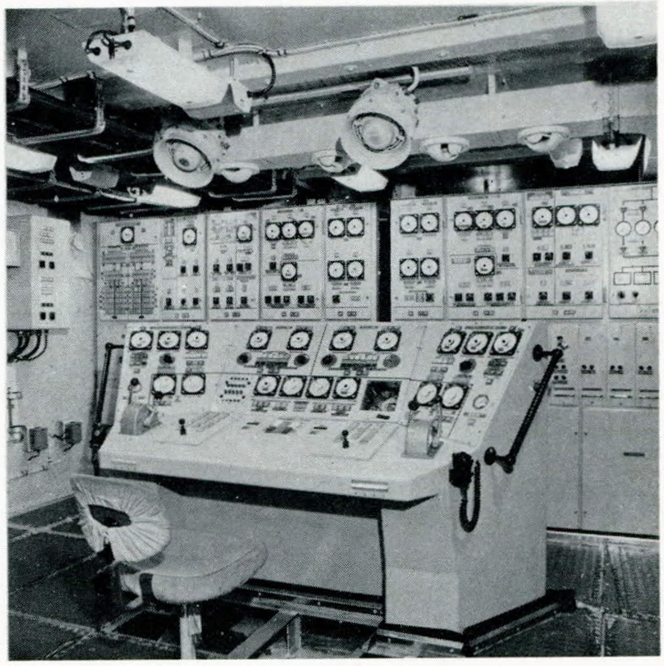

Fig: 7

through a 30" diameter hatch.

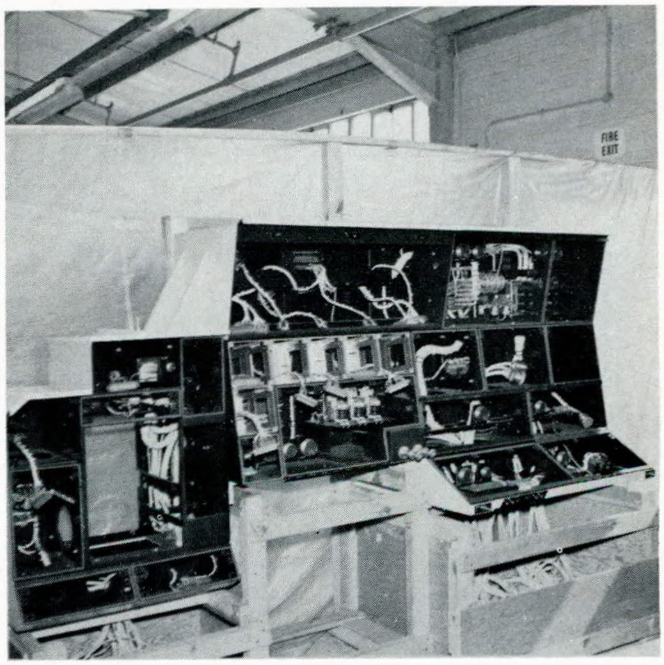

Fig: 8

As a final example, Figure 9 shows a load centre using Moulded Case Circuit Breakers in a distribution network. The main feature of interest is the construction which is based on an aluminium alloy 'picture frame' on which the majority of equipment is mounted. Stringent MOD shock and vibration requirements were met and weight minimised by using this form of construction and skinning the complete assembly with a VCS type of framework of the lightweight grade.

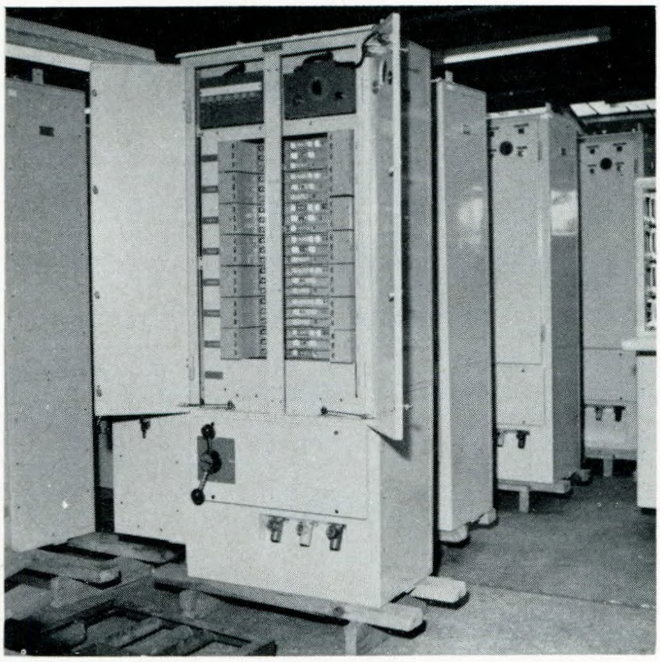

Fig: 9

A Shipbuilder's View of VCS

The advantages of VCS for ships' operators have already been indicated. Advantages from the shipbuilder's point of view can be summarised thus:

(a) Fund of VCS experience and knowledge already available in MOD outside companies, and own organisation.

(b) Standard units already available.

(c) Console specification and part design already laid down.

(d) System enables 'building block' design approach to be adopted; modular units can be manipulated, either in mock-up or reality, to produce optimum layout.

(e) Reduced design, drawing and production costs through factors (a), (b), (c) and (d)

(f) System accommodates consoles of different shapes, sizes and strengths for different requirements and positions in the ship.

(g) Wiring standardisation increased.

(h) Console standardisation increased.

(i) Consoles can be installed and pre-wired before equipment is available, circumventing potential delivery problems.

(j) Damage to equipment avoided by installing and wiring consoles without modules.

(k) Installation time and costs reduced through factors (g), (h), (i) and (j).

(l) Trials or operational experience readily embodied in the form of modifications.

(m) Down-time of systems during shipbuilders' trials and evaluation reduced.

(n) Cost to shipbuilder of logistic support before commissioning reduced.

(o) VCS principles useful in 'adapted' systems.

The factors which can militate against the use of VCS are mainly economic, the difficulty of adapting certain systems to the VCS format, and weight or size penalty in a few applications. Several examples have already been given of why VCS has not been used in certain areas. It is also noticeable that VCS is not often found to be the most cost-effective approach in smaller warships, such as fast patrol boats, or even in larger ships where more than one vessel built to a particular design is not envisaged.

Recommendations regarding the implementation of VCS

As a result of experience over many years, the author's organisation feels qualified to make certain recommendations and hopes these will be helpful to all having any responsibility for implementing the system.

1. Modules

One innovation which could perhaps receive wider specification, is the inclusion on modules of built-in test facilities permitting on-line in-site testing. An example has already been mentioned in connection with the VCS form of modular construction employed on machinery control systems. Similar facilities are included in some of the modules developed, under private venture arrangements, to augment the range already on the VCS register.

2. Internal Wiring

In general it has been found that all operations on internal wiring, including initial looming and later modifications and servicing, are most easily carried out against wiring schedules, and do not require wiring diagrams. It could be argued that the high cost of producing wiring diagrams, up to 30% of the total drawing cost of any new VCS console, is not fully justified.

As an example of what can be achieved, a machinery control test rig was recently produced using VCS, entirely without wiring diagrams. Schedules were adequate for manufacture, testing, and implementing modifications.

A second point in relation to wiring involves modification. Every customer would like to believe that his specification is final, but this rarely proves to be the case. VCS, being at the centre of network type systems (eg: communication) suffers modification on a 'compound' basis. The tendency is, therefore, to initially wire VCS consoles more extensively than is ever conceived at first. The simplicity of carrying out modifications with equipment which already contains spare wires, as against the difficulties of re-looming, particularly on board ship during construction, justifies the small percentage extra cost. However, commercial considerations in a more competitive market sometimes precludes this. It is therefore recommended that spare wires and terminals are included in customers' initial specifications.

A third point concerns practice in relation to terminals. It can be argued that installing intermediate terminal grids in each console is far preferable to leading ship's wiring directly to the multibox connectors. Problems of internal wiring are tremendously eased since connections can be changed at will very quickly, and the risk of damage to wire cores or connectors is greatly reduced. Again, the costs of extra terminations are thought to be well worth the extra flexibility and possibly reliability, achieved.

General arrangement drawings and parts lists

A similar argument to that put forward against wiring diagrams can be posed against many general arrangement drawings and parts lists, since these have been found to be of only limited use. It is thought that the authorities responsible could forego some of the drawing and information requirements with considerable benefit to costs.

Conclusion

In conclusion, the author believes that the Versatile Console System has a major role to play in future naval ships, and could also be adopted with advantage, by a proportion of the world's mercantile fleet. The flexibility of this type of equipment is increasingly recognised and a general view is that its application should be extended as far as possible in naval and in other marine and industrial environments.

List of Tables

List of Illustrations

The author also wishes to acknowledge the assistance freely given him by his employers and particularly by members of the Electrical Design Department (Shipbuilding) and the Products Division, in preparing this paper.

DISCUSSION

MR. D.R. WILKINSON said that he had listened with great interest and several aspects of the VCS system came to mind which he would subsequently mention. He felt uniquely qualified to open the discussion, in one respect at least, viz neither he, nor his company had any vested interest in furthering the principles and design, production and quality assurance or the application of the versatile console system, thus he could be truly unbiased. This was not to say that his company did not use the system however.

He would divide his remarks into four categories, viz., one for each paper and a fourth which is how he believed the most important category of all would reply, namely the operator/maintainer.

As a preface to his remarks, he had studied the papers intently to deduce what message it was expected to convey and, as he saw it, it was twofold;

i) to "sell" the VCS system to other than MOD(N) users, e.g. merchant ships;

ii) to describe origins, development and use of the VCS system.

He had no doubt that the second aim had been very well covered by all three papers and would comment on that later, but he suggested that the first and more difficult aim had not really been achieved.

He would go further and state that such an aim would be very difficult to achieve, for the simple reason that the main incentive to use the VCS system, viz., extreme compactness of complex systems was not generally present: one could well imagine the possible incongruity of a very large navigating bridge occupied only by some efficient but small VCS consoles. Also, and related to this, extreme compactness did not come cheap and, in a highly competitive merchant ship market, the additional capital and through costs of the VCS system could well contribute to a non-competitive bid. He would be enthusiastic to increase the use of the VCS system beyond naval ships; did the authors foresee any way in which a "commercial" form of the present system could be produced, for example, retain the present "packaging" arrangements for VCS units, but introduce a limited range of less expensive units. He had little doubt the basic format of the presentation would be very suitable.

Mr. Beck's paper presented a very good background into the origins and development of the VCS system, to which little could be added. It was impressive to observe the exhaustive analysis which led to the present system. One general point which occurred to him, on reading the paper, was that sufficient credit or emphasis was not given to the system design flexibility which the VCS system conferred and it was worth adding a few remarks in this vein.

A VCS console, overhead assembly, or whatever, really achieved three main tasks;

i) it acted as a control centre;

ii) it provided communication in the broadest sense;

iii) it acted as a focal point for system interconnection.

The first two points were dealt with in the papers and were used in a point to point basis, e.g. navigating bridge to steering compartment, control room, operations room, etc., but it should be noted that a complete and, in many cases, complex control system, involving several VCS units, would normally be housed in one console, thus enabling all interconnection wiring for that system to be completed and tested, before it ever reached the ship. For example, the steering control system in a modern warship was easily housed in a small console, only requiring connection to the ship's cables and, therefore, time to reach the setting-to-work stage was short, compared with having to wire up discreet components in the ship. Thus, where fitting out time far exceeded building time, use of the VCS system must contribute to reducing this phase.

He could only support claims, made in the papers by Mr. Beck and Mr. MacGregor, regarding the flexibility of use in planning ship's compartments. Here again, the ship designer and builder was be-devilled by available space and, as so much could be packed into consoles, etc., it was of great advantage. Also, the ability to be very confident of early predictions of weight, space and support systems was extremely beneficial. Equipment and system growth, as design and build proceeded, must happen, but the more this was limited, the better would be the ship. Oddly enough, he believed those who designed and built submarines regarded even VCS units, etc., as bulky, and as a result their use was limited. All this was relative and would the authors care to comment ?

He felt the photographs of mock ups and actual ship installations might do a little less than justice to the system. Fig. 3 of Mr. Beck's paper looked to him as being a very good example of marrying VCS consoles to the ship, in that both the command and the operators seemed to have excellent all-round vision and control. He was not so sure about Fig. 9 and Fig. 2 of Mr. MacGregor's paper; vision cut-off outside the bridge windows would be considerable, compared with Fig. 2. Perhaps the console ergonomics had taken precedence over the more vital requirements for command to have the best possible vision.

At present, ship's cabling terminated in the VCS terminal chambers and he agreed that valuable space was lost here. Would the authors comment on arranging ship's cabling to terminate on each VCS unit, using plugs and sockets in lieu of large numbers of terminal strips ? This could reduce the cost of the consoles and provide more space for other equipment.

Data presentation was largely analogue at present, with slight digital overtones. Analogue would give way to digital which would eventually be usurped by visual display units. That looked far enough ahead for now. Nonetheless, he had looked at this aspect and sought various opinions and, whether by good foresight and design or sheer good luck, the VCS console philosophy should still be an excellent basis for packaging such techniques. Having swallowed that, it was but a step to imagine VCS for the microprocessor and telemetric data transmission also.

He had learned quite a lot from Mr. Beach's paper, which went a long way to explaining the general satisfaction which existed in builders and users alike. He could confirm that the console design aspect which was of great interest to the ship arrangement, could be undertaken by shipbuilders' staff, as his company had done in previous ships. They had also developed numerous VCS units and these were recorded in the VCS register; however, he had to report that the Ministry of Defence was a little less than enthusiastic to adopt such developments for general use. Perhaps his company's thinking was a little too advanced at that time.

The typical unit, shown in Fig. 4 of Mr. Beach's paper, seemed to be crying out for miniaturisation, but he accepted that it was impossible to be completely up to date. In relation to previous comments regarding relative bulkiness, would a small VCS unit standard become available, or was system complexity likely to increase, thus requiring the same space for more equipment.

At present, the console maker(s) wired each console, from the terminal chamber to the McMurdo socket, from a set of VCS drawings or schedules. Assuming the drawings were correct and quality control (Q.C.) had shown the consoles to be correct to drawings, all should be well. Nonetheless, where the console was an Admiralty Supply Item, the shipbuilder would only check his wiring to the terminal chamber and small areas of potential trouble could exist there. Would plugs and sockets replacing terminal chambers improve the position ?

Would Mr. Beach care to comment on the need for such a vigorous (costly ?) Q.C. procedure for the VCS units ? In his opinion, once production runs were established, could they be relaxed somewhat ? Whilst "perfection was not the aim of Q.C.", as stated by Mr. Beach, his company must come close to it with these controls. He would be interested, also, to learn what sort of rejection rate occurred by applying these Q.C. standards.

Would Mr. Beach care to comment on the extent to which Q.C. was involved in environmental testing and to what extent consoles and units were tested in this respect ?

Mr. MacGregor's paper largely paralleled his own company's experience and earlier comments applied here also. He was interested in Mr. MacGregor's suggestion regarding on-line testing and would agree with the concept providing the complexity was not too great. He believed some VCS amplifier units now in service had facilities for dynamic monitoring and signal injection, so this seemed to be an acceptable trend.

This paper included reference to "adapting" VCS principles, which was another valuable property of the system. A number of the ship's consoles in his company's programme used VCS construction methods and units, albeit in consoles outwith standard shapes. Even if potential users did not use VCS units, it was a simple and quick way of building consoles.

He had sought opinions from naval officers, resident in his company's shipyard, as to their experience as operators of the VCS system and their experience seemed to confirm that ergonomic and anthropometric aims had been largely achieved. The only criticisms of any note were;

i) generally controls were more delicate than heretofore and operators had to be re-educated in their use; time and perhaps some short training course could help here;

ii) there was a great need for a VCS unit fitted with coffee cup holders.

This second item was a serious comment; coffee spillage had occurred and had resulted in expensive replacements. One hoped that all reasonable operator comforts had been considered.

MR. C.H. DAVIS said that Mr. Beach had told them that a VCS console was a framework built to a specific shape, and fitted with a multibox that received the VCS units. He had explained that the framework was built from a range of proprietary, aluminium, extruded members and fittings. Mr. Davis declared his interest, insofar that he was the Technical Director of the manufacturer of these parts.

Mr. Beck, in the opening paper, used the word "versatile" in the name of the VCS to cover equipment housings in an indefinite variety of shapes and electrical content. Mr. Davis wished to illustrate how the adjective "versatile" could also be extended to the strength of the framework. The figures of shock resistance, quoted by Mr. Beck, referred to a framework constructed to the standard specification and fitted with a multibox to complete the console, or assembly. Whilst not deprecating his own product, he said that the framework and the multibox gave strength to each other. Quite obviously, the boxes themselves had low inherent strength, but like the cardboard separators of the common egg box, they provided essential, supplementary strength to the framework itself.

If, therefore, a console was built without the usual VCS multibox, steps must be taken to strengthen the framework suitably. This could be done without difficulty and such strengthened frameworks considerably extended the scope of the system. They would provide consoles that would carry heavier loads than usual and would withstand shocks of greater severity than was normally required. They could also be used to support equipment that did not lend itself to being built in the form of VCS modules.

As an example, he quoted a VCS assembly with the upper unit considerably heavier than normal, 17kg, compated with an accepted VCS average of 3.5kg, per 152mm x 152mm cell size. The VCS boxes were fitted into a strengthened framework and the complete equipment was so sturdy that it could be bulkhead mounted without shock mounts. (Fig. 1).

Mr. Sallabank had mentioned "Adapted VCS", and had shown how a framework of orthodox construction could also be clad with the smaller range of VCS framework components. Whilst each case must be judged on its merits, a strengthened framework could be used to support equipment directly. Such consoles could be conveniently referred to as "hybrids".

Another example was a console built from a strengthened framework. The complete equipment weighed 360kg and had successfully passed the severe shock and environmental tests that were specified (Fig. 2).

Much of the special electronic equipment was mounted on hinged panels, but common ships indications were presented by the use of standard VCS units. The multibox assembly, in which these were fitted, was situated above the sloping desk (Fig. 3).

Visual display units did not always lend themselves to packaging into a VCS unit, particularly when space was limited, or on-line maintenance necessary. An alternative was to mount the VDU on telescopic slides in a strengthened framework.

In typical VCS framework console, in which the larger units had been mounted on telescopic slides, the panel sloped to give a good ergonomic shape, but this in turn meant that the chassis were tilted and tended to slide back when extended (Fig. 4).

There was a special locking system that prevented this. The drawer could only be moved when the operating latch was depressed. This ensured that if the operator momentarily released his hold, due for instance to unexpected ship movement, no injury to personnel or damage to equipment resulted. The fact that this had passed the specified shock and vibration conditions, illustrated the suitability of the system to the stringent requirements made in this type of work (Figs. 5 and 6).

He trusted that his examples had shown how the VCS could be extended to make it even more versatile than the authors of the three papers had indicated.

MR. A.P. BAINES called attention to the difficulties and inaccuracies resulting from presenting the VCS units, which were made to standard Imperial dimensions, on equipment drawings for ships where the metric system was required.

Correspondence

CAPTAIN J. DE COVERLY wrote that as one of those peculiar people who inhabited the bridge, he spoke with some hesitation in that assembly, but as bridge equipment and controls had received considerable attention in the papers they had just heard, perhaps a few words were justified.

The subject of what was often called bridge ergonomics was being quite extensively discussed at present in the field of merchant ship design, as well as in that of warships, and the Department of Trade was taking a keen interest. The reason was simply that there had been a vast increase in the number of items fitted in the wheelhouse and chartroom, because of both the multiplication of pieces of navigational

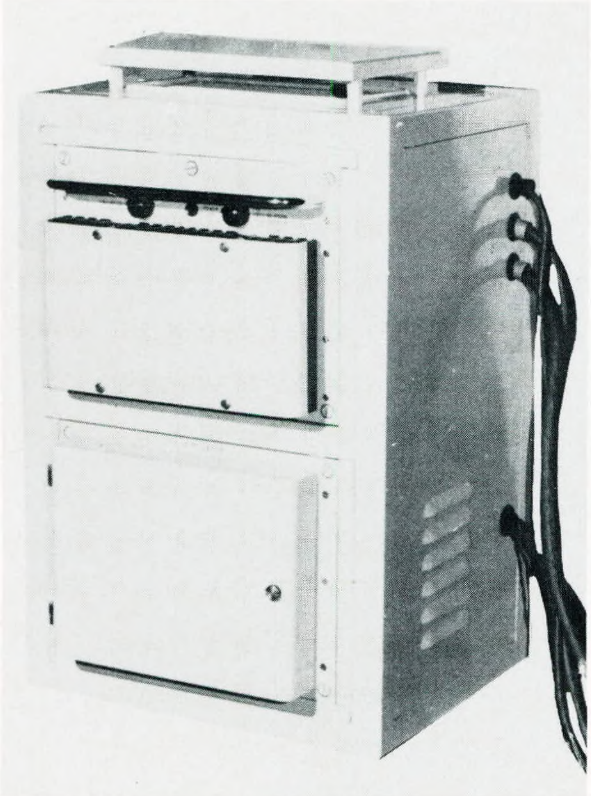

Fig. D1 – Heavy duty console

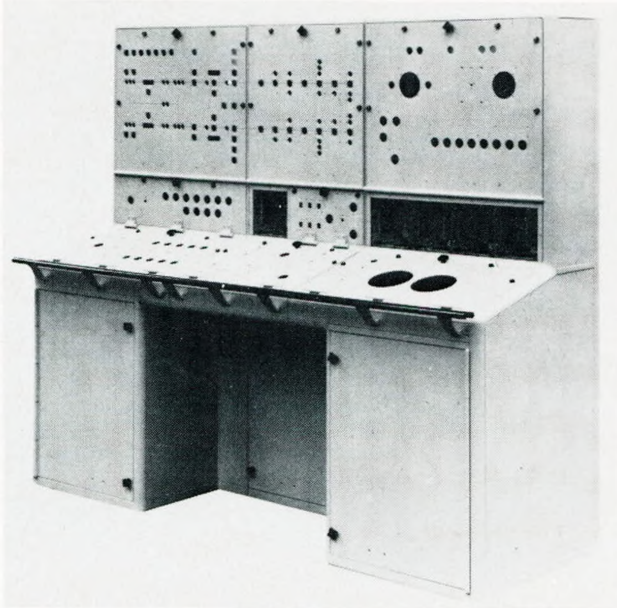

Fig. D2 – Strengthened frame work closed up

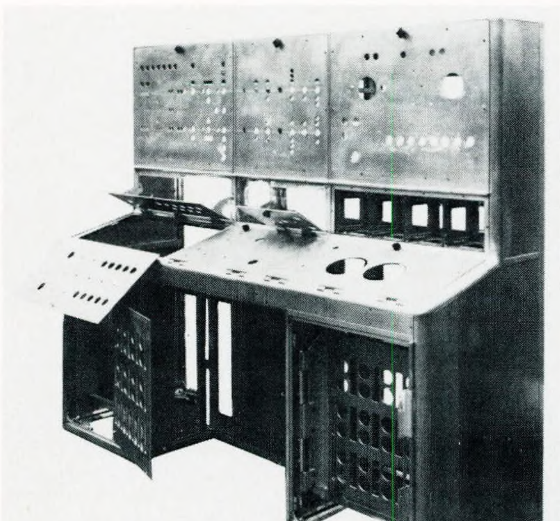

Fig. D3 – Strengthened frame work opened

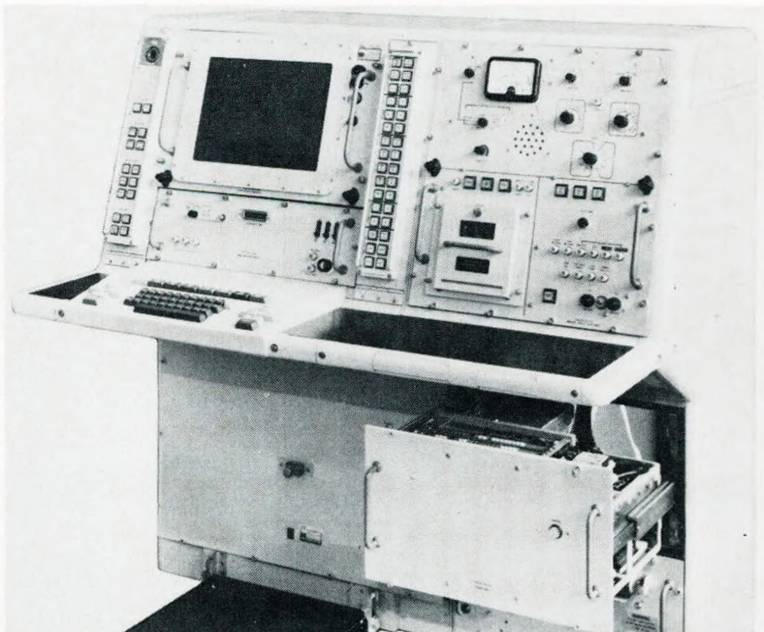

Fig. D4 – Console using telescopic slides

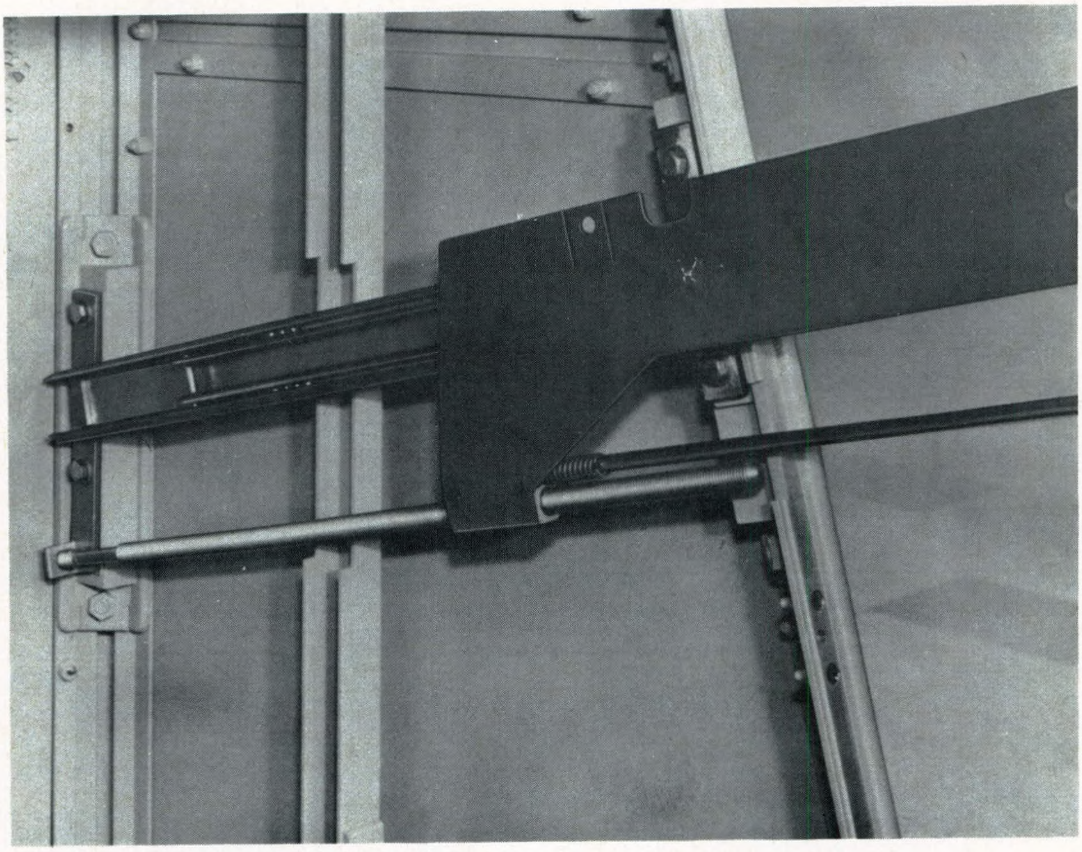

Fig. D5 – Locking system for sloping slides

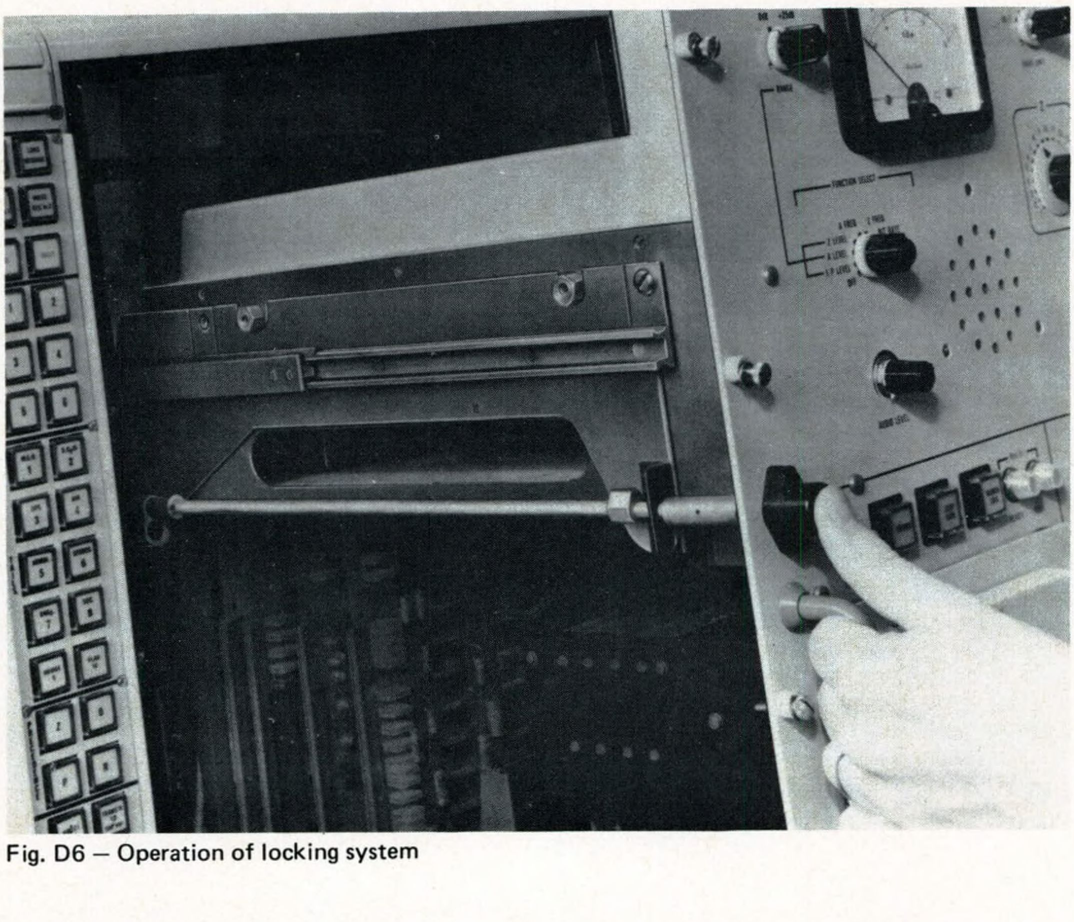

Fig. D6 – Operation of locking system

equipment and the tendency to centralise control and monitoring. A few years ago they had a compass, wheel, telegraph and perhaps a few other items such as echo sounder, log and a smoke cabinet; now there were, as well, probably two radar sets, two or three other position finding devices, automatic helmsman, bridge control of the engine, a comprehensive fire warning system, engine and perhaps cargo hold monitoring, and an extensive internal and external communications system. Yet they still needed just as much room as before for the tools of what might be called traditional navigation; and they needed to be able to look where they were going. There was, thus, an ever-increasing demand for bridge space, and, so that one could be sure that the proper priorities were maintained, that the most important items were to hand when needed, and that an officer newly joining a ship did not have to spend too much time simply finding out where everything was, there was a temptation to look for a few standard designs which would meet all needs and one of which could be followed on any ship. On the other hand, there was a grave danger in this approach, for an excess of standardisation tended to stultify initiative and inhibit useful developments. The versatile concept, which they had just heard so lucidly described, seemed to offer a middle way, whereby one could have many of the benefits of standardising and yet maintain that flexibility of approach which was surely a first essential of good design.

AUTHORS' REPLY

Mr. Beck, on behalf of the authors, thanked Mr. Wilkinson for his most constructive and stimulating comments. Many of the points raised, particularly on the practical shipbuilding aspects, were especially valid. It had not been the primary aim of the papers to attempt a "hard sell" of VCS to the merchant shipping industry, but rather to describe the main features of the system and the advantages it had to offer in particular applications.

As Mr. Wilkinson had said, VCS was most suited to sophisticated smaller vessels, and some initial equipment cost penalties might have to be borne. However, with more complex operator facilities coming on to bridges, the advantages of VCS were likely to provide an overall life cycle cost effective solution.

Mr. Beech considered that VCS consoles and units could be made cheaper if adherence to Defence Standards was relaxed and ruggedness requirements were satisfied by a wider use of resilient mounts. Another factor was that Marine Superintendents were reluctant to authorise re-engineering of standard bridge equipment to the modular concept, for one or two ships of a type.

As regards fitting of VCS in submarines, Mr. Beck said that VCS consoles were fitted to a limited extent and submarine designers considered almost all equipment to be too bulky.

In reply to Mr. Wilkinsons criticism of Fig. 9 of Paper No. 1, and Fig. 2 of Paper No. 3, Mr. Sallabank commented that he thought the photographs had been taken from an unfortunately low position. The total ergonomics of console design included the consideration of operators total visual requirements. The actual operation of the Mk 10 frigate vindicated this point, and this was also a feature of prime importance which was checked using the full scale mock-ups.

Mr. Beck considered that the subject of the termination of ship's cabling in plug and socket form was a subject worthy of a discussion session in its own right. As far as VCS was concerned, ship's cabling for most overhead assemblies was terminated directly on to the back of the McMurdo sockets. With present consoles the terminal strip arrangements were used extensively for circuit interlinking and the use of external junction boxes could be avoided. Much of the flexibility, particularly for modifications, would be lost with plugs and sockets. However, use of plugs and sockets could possibly give a reduction in cost and some space savings for particular applications and this was being considered.

Commenting on Mr. Wilkinsons remarks on miniaturisation, Mr. Beech said that this was considered for units where function and operator controls allowed, e.g. LED's, mother and daughter printed circuit board techniques, etc. Mr. Beck added that, as mentioned in Paper No. 1, a small size ($6^{in} \times 2^{in}$) VCS unit was being introduced, but that it did seem to be a fact of life that the space savings made possible by advances in component technology were quickly taken up by the increased complexity needed to give improved performance and extended system capability. What must be looked at carefully was whether the improved performance and capability was really necessary.

On the question of console wiring terminations, Mr. Sallabank said that the use of plugs and sockets would not significantly reduce the number of wiring errors, as they were generally proportional to the number of connections concerned.

With reference to quality assurance, Mr. Beech said that the QA procedures applied had been found to be cost effective, and the rejection rate for units was less than 0.1 per cent. For consoles, the rejection rate was 0.1 per cent for electrical content and 0.5 per cent for mechanical content (as the console was basically a mechanical type structure). These figures more than justified the QA procedures adopted.

Prototypes of all units were fully environmentally tested to Naval specifications, and consoles only when specified by the design authority - or for a new class of ship. Some selective testing took place for follow-on ships. All tests were witnessed by engineering project staff and reports were issued.

Mr. Sallabank, commenting on the suggestions for on-line testing of modules, said that the requirement for built-in test facilities depended largely upon the complexity of the system being considered and the equipment provided must be compatible with the on-board maintenance philosophy adopted.

Concerning the reference to spillage of coffee, Mr. Beech said that some consoles had facilities fitted for stowage of coffee cups, where specified, but for other ships their provision had been discouraged. It would be very expensive to make VCS "coffee proof".

The authors noted with interest Mr. Davis' description of the further ways in which VCS principle could be utilised; the telescopic slide locking mechanism was of particular note.

In reply to Captain J. de Coverly's written contribution, the authors were particularly pleased to receive the favourable comments on VCS from an experienced member of Merchant Marine circles, and Captain de Coverly had identified precisely the considerable benefits of standardisation with flexibility of approach which VCS offered.

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