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THE FIRST YEAR'S EXPERIENCE WITH A MICROCOMPUTER IN A SHIPPING COMPANY

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The First Year's Experience with a Microcomputer in a Shipping Company

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SYNOPSIS

The author discusses why it was decided to purchase a microcomputer for head office and the type of system purchased. The main units are described in engineering terms, including size, capability and cost. Various applications include monitoring the daily fuel consumption, hull roughness, spare gear and planned maintenance. The effectiveness of the system is appraised and teething troubles described. General guidance on the type of system suitable for such applications is included. The paper is intended for those with little knowledge of microcomputers and electronic technicalities are only discussed superficially. Some basic computer technical data and terminology are, however, included in appendices.

INTRODUCTION

Due to the capability, versatility and relatively low cost of microcomputers, computing has been given a new dimension. Microcomputers are now being designed for easier use by non-specialists. When provided with suitable programs, they can be operated by most people after little training. At present, the range of microcomputer programs readily available is limited. However, the number of sources and people capable of providing both general and specialized programs is increasing rapidly.

Many existing tasks suited to but currently not generally done by computers can be handled more cost-effectively, quickly and accurately, using a microcomputer system. Their use will become widespread in industry and commerce, particularly in smaller organizations.

To become competent to use all of the facilities offered by a typical system can take many months but sufficient expertise to operate the system in a useful, albeit basic, manner can be learnt in several hours.

A glossary of computer terminology used in this paper is listed in Appendix 1.

After an engineering apprenticeship at Messrs Cammell Laird & Co. (Ship-builders & Engineers) Ltd, Birkenhead, Mr Perry spent 2 years in the engine drawing office. He then obtained motor and steamship experience with Shaw Savill & Albion Line and the Canadian Pacific Steamship Company. On coming ashore in 1961 he joined the Cunard Steamship Co. Ltd in their Design & New Construction Department which later became Cunard International Technical Services. He has been involved with *Queen Elizabeth 2,* three generations of offshore tug/supply vessels, bulk and product carriers, and ro-ro and cellular container new tonnage. In 1977 he became a superintendent engineer in the cargo ship division, later becoming specifically involved in planned maintenance, hull and machinery technical performance monitoring and analysis of the Cunard cargo fleet. He became involved in microcomputers in 1979.

Reason for using a computer

Initially a study was made of frequently-recurring tasks in assessing technical and operating data received from vessels in the cargo fleet. Only tasks that were the direct concern of the Technical Department were considered. It was concluded that, to save overall time and cost, computerized techniques could be used to advantage. Applications initially considered suitable included:

Voyage technical data assessment and storage on computer files.
Fleet spare gear stock control and cost audits.
Planned maintenance and classification society survey cycles.
Hull and main propulsive plant performance computations.
Combined technical/economic calculations to derive 'best operating speed'.

All of these applications have been developed to various extents. The upward spiral in world fuel costs caused the emphasis to be put on those applications directly related to fuel management. This has resulted in substantial fuel savings being made. It is considered that the total cost of the system has been justified on these grounds alone.

Why a microcomputer?

Common computer types are mainframe, mini, desk-top, personal/home and/or desk micro. Until recently, type and capability were strictly related. Current microcomputer technology has drastically changed this. Now, an initially very basic personal/home microcomputer system can often be readily upgraded to provide facilities associated with much larger and more expensive computer systems. The degree of the improvement can only be described as revolutionary. This paper is written around such a system.

The main reasons for choosing a microcomputer are as follows. Its computing capabilities were adequate for our needs and can be further upgraded. Initial costs are modest; installation and running costs are very low. The system is completely self-contained: almost total control can be kept within the Department. Furthermore, there is great potential growth in this branch of technology and the staff directly involved were keen to participate. Finally, the equipment is portable and potentially suitable for shipboard use.

Experience to date has been encouraging in all respects but the installation of such a system on board ship is not currently planned.

Which microcomputer: cost and size

To suit the applications discussed in this paper, there are currently six or more microcomputer systems, and the number is increasing.

Technical details of the actual system purchased are listed in Appendix 2. It is classed as a personal computer and only fulfils one task and supports one person, at a time. Technically it has greater potential than this.

The system consists of a number of individual units, and fits easily on top of an office desk. The units comprise:

- Microcomputer unit complete with typewriter-style keyboard.
- Visual display unit (VDU).
- Printer.
- Expansion unit (an optional extra which enables the microcomputer unit to communicate externally).
- Magnetic storage units 3-off, termed 'micro floppy disk units'.

A basic system providing similar facilities to that purchased and including some standard software would currently cost approximately

£3500. Due to technical progress and increasing competition between equipment manufacturers, value for money will continue to increase in the foreseeable future.

Systems suited to business applications of the type detailed in this paper vary in price from £1500 to £4000. The more expensive invariably provide greater data storage capacity and are more flexible and convenient to use.

Capability of a microcomputer

A computer is a device capable, in its own manner, of imitating some of the basic human thought processes used to solve problems. Those that can be converted into mathematical terms are amongst the easiest to accommodate.

Generally, if a problem can be solved by following a logical sequence of unambiguous steps, then some form of computer program can be written to achieve this automatically. Decision-making can be part of this sequence, provided that absolute choices only are incurred, i.e. 'true or false', 'yes or no', 'greater or less than' situations. A modicum of intelligence can be written into many programs, enabling the computer to test whether or not data or instructions are sensible.

Writing a computer program consists of breaking the sequence of operations down into very simple elements, and successively converting each into instructions acceptable by the computer. Each program can be allocated a name under which it can be stored and, when required, retrieved from the computer filing system. When the computer is commanded to 'run' a program, every instruction it contains is automatically carried out in strict order. The program therefore determines which facility, of the many alternatives possible, the computer is to provide.

To change from one program to another is quick and easy. This means that it is convenient to use the same computer for a wide range of tasks. Apart from being able to perform tasks accurately and automatically, its speed is impressive, enabling it to add hundreds of numbers together in one second or produce typed output at up to 115 characters per second.

Many potential users initially do not have sufficient expertise to write programs. The possibility of utilizing a microcomputer should not be dismissed on account of this, as there are several solutions to the limitations this imposes.

APPLICATIONS

Prior to installing the microcomputer, it was decided that it would, initially, only provide alternatives to existing methods and bases for direct comparisons. Only if the new method was better and acceptable in all respects would adoption be considered. It was not a case of 'could the micro be used' but rather 'which work should it be used for'. It was already known to be sufficiently versatile for each of the applications envisaged.

Regularly-performed tasks were listed. For each task, brief notes were made of how and what was involved, using (a) the existing method, and (b) the computer. An estimate of the time required to write and check a computer program was included. It was then quite easy to decide which applications should be tackled and in which order.

This study also enabled established procedures to be reviewed in the light of current, and anticipated future, requirements. Whilst, in the early stages, attention was directed towards individual applications, the importance of adopting a co-ordinated overall policy was also realized. This has been reflected in the programs developed.

The following applications are primarily intended to demonstrate the wide variety of uses the system is suitable for.

Voyage data assessment

Figure 1 depicts the Passage Information Form, one of our fleet's several standard reporting documents—on which up to 70 items can be recorded. These are fundamental data elements, and a variety of operational and performance information is derived from them. Each completed form provides data associated with one sea passage including the period spent in the departure port; and is a major source of technical information.

By transcribing and storing these data in permanent computer files, they can be quickly retrieved and merged with selected programs, so that any information that can be derived from the permutations can be automatically computed.

If accurate information is to be derived, then the data transcribed from the forms into the computer must be correct. The computer is not responsible for faulty entries on the form or input errors but, as accuracy is important, 'error trapping' routines are embodied in all such programs. Most Passage Form numerical entries will normally fall within a certain range. If this is defined, the computer can test the data being processed, and indicate if any inputs are outside the limits.

As information derived from these data is valuable to management, a range of programs have been developed to obtain this quickly, with minimum effort. Each program, whilst being self-contained, can be merged with any or all of the others. Typical programs yield the following:

- Voyage data numeric value validity check, i.e. error trapping routine.
- Date sequence check, i.e. missing forms when processing in batches.
- Days elapsed from datum date, i.e. last drydocking, etc.
- Totals and cumulative values of specific entries on the passage form.
- Fuel and lube oil audits based on single, and groups of, Passage Forms.
- Fuel, lube and feed water specific consumptions based on single, and groups of, forms.
- Passage hull and propulsive plant performance assessment.
- Trend analysis of relative hull performance; boiler feed water and main engine crankcase oil consumption, etc.

Currently, data output is mainly in tabular format but programs are being developed to provide pictorial displays where this is considered advantageous. Figure 2 shows a typical printout.

Ship operation economics

Determination of the 'least cost' or 'most profitable' speed for a particular vessel, taking into account all major technical and commercial cost elements, involves a considerable amount of calculation. Using the microcomputer, a comprehensive range of information for each of a range of speeds can be quickly and automatically produced on hard copy.

FIG. 1 The passage information form

CUNARD SHIPPING SERVICES

FORM E5/TS1 1976
REPLACES E5

Passage Information

SS/MV			
FROM	TO	DEP DRAUGHT FORD AFT	
DEPARTURE DATE TIME		ARRIVAL DATE TIME	
TIME ON PASSAGE DAYS HOURS MINS		TIME IN DEP PORT DAYS HOURS MINS	
AVERAGE REVS PER MIN RPM		SPEED KNOTS	SLIP %
AVERAGE ME BHP COMBINED AVERAGE AUX ENGINE KW K READING		MILES PER TON OF FUEL MILES DISTANCE STEAMED MILES	
DETENTIONS DAYS HOURS MINS		PORT DELAY DUE MACH DAYS HOURS MIN	
REMAINS AT START OF PASSAGE	HO TONS/TONNES DO TONS/TONNES	CRANK LO LITR CYL LO LITR	AUX LO LITR

CONSUMPTIONS	LAST PORT		ON PASSAGE	
	TOTAL	DAILY AVERAGE	TOTAL	DAILY AVERAGE
MAIN ENGINE FUEL OIL				
BOILER FUEL OIL				
TOTAL				
MAIN ENGINE DIESEL OIL				
BOILER DIESEL OIL				
AUX DIESEL OIL				
TOTAL				
MAIN ENGINE CRANKCASE				
GENERAL PURPOSE LO				
MAIN ENGINE CYLINDER LO				
AUX ENGINE LO				
MACHINERY WATER				
DOMESTIC WATER				

BUNKERED AT LAST PORT			
GRADE HO VIS	HO TONS/TONNES	CRANK LO LITR	
GRADE DO VIS	DO TONS/TONNES	CYL LO LITR	AUX LO LITR
REMAINS END OF PASSAGE	HO TONS/TONNES	CRANK LO LITR	
(EXCLUDE SUMPS)	DO TONS/TONNES	CYL LO LITR	AUX LO LITR
SUMP CONTENTS START OF PASSAGE LITR		SUMP CONTENTS END OF PASSAGE LITR	
LUB OIL LOSSES LITR	REASON		

WEATHER/CURRENTS/FOULING AS AFFECTING SPEED:–

The program required to achieve this is quite complex. For instance, it must be able to deduce the SHP requirement for any combination of operating speed and draft, so that daily fuel consumption costs can be determined. Refinements, such as hull and main engine performance, non-availability or reduced efficiency of auxiliary boilers, etc., are catered for. If the selected ship's draft is such that ballast is required for stability reasons, the program automatically calculates this and includes a suitable statement on the printout.

The program is simple to use as it only requires the operator to type in answers to the following questions:

Voyage miles?
Total number of days at loading and discharging ports?
Extra days allowed?
Weekend days allowed?
Canal transit time in days?
Total cost of port dues?
Total cost of canal dues?
Loading expenses?
Discharging expenses?
Daily operating cost?
Unit cost of heavy fuel oil?
Unit cost of diesel oil?
Hull/weather performance factor?
Average electrical load at sea?
Average electrical load in port?
Maximum, minimum and incremental speeds?
Draft, volume or weight of cargo?

Having entered the foregoing, a condensed printout, listing the basis of the computation, is provided, together with values for each of the following variables, at each increment of speed:

Speed in knots.
Total days for trip.
SHP.
Heavy fuel oil consumed, in tonnes per day and cost.
Total voyage cost.
Profit per day.
Cost per mile.
Time charter equivalent.

Substantially more information can be outputted if required, e.g. quantity of exhaust steam produced, and kW load taken by steam turbine and diesel alternator sets. Any variable that can be derived from the mathematical model which forms the basis of the computer program can be made available. The program can determine the effect on overall cost-effectiveness of a particular element; the effect of change in fuel price is one important example.

```
M.V. TESTPROGRAM
*************************************************
HERE to THERE DEP. DATE 15/01/82              (Drydock + 122 days)
*************************************************
   SPEED   DRAFT   R.P.M.  %SLIP   T.P.D.  MILES  COP ENG.  COP HULL
    21.2     7.0   100.0     4.1    67.0  4580.0   0.980     0.968

AUDIT DISCREPANCIES (Fuel & Lube Oils)
--------------------------------------
                    H.F.O.      D.O.    CRANK      SUMP      CYL      AUX
B/F     AUDIT          0          0        0         0         0      508
PASSAGE AUDIT          0          0        0         0         0     -508
              ------------------------------------------------------------
GRADE   AUDIT          0          0        0         0         0        0
              ------------------------------------------------------------
ACCUM.  AUDIT          0          0        0         0         0        0
STOCK REMAINS        891         55    79025     50000      6400      724
DAYS RESERVE          11          8      490                  21       12
L.O. LOSS OF 130  Litres due to PIPE WELD FRACTURE


Ship Utilisation Factor = 58 % & at 94% of Service Speed

CURRENT LUB OIL CONSUMPTION ASSESSMENTS
---------------------------------------
              M.E. C/C OIL     M.E. CYL OIL       AUX LUB OIL
              DAILY   TOTAL    DAILY   TOTAL      DAILY TOTAL
ACTUAL          105     945      284    2560         82  1276
PREDICTED        91     818      273    2455         80  1245
.............................................................
VARIANCE         14     127       12     105          2    31
.............................................................
% Variance           15 %            4 %                2 %

CUMULATIVE DATA
---------------
            H.F.O.    D.O.   CRANK     CYL.   AUX L.O.LOSSES   WATER
Used         609       95     945     2560    1276     130       229
Av.daily                6     105              82                 15

 Miles      Sea days  Sea dets.Portdays Portdets Total days
  4580.0       9.0       0.0       6.5      0.0       15.5

Percentage of Financial Year elapsed= 4 %
Cumulative Ship Utilisation Factor= 58 % & at 94 % of Service Speed
Cumulative Steaming Speed =  21.2 knots

CUMULATIVE L.O. CONSUMPTION STATUS
----------------------------------

              CRANK      CYL       AUX  LOSSES   TOTAL   DAYS / MTHS
Predicted       818     2455      1245       0    4518       16 / 0.5
Actual          945     2560      1276     130    4911       16 / 0.5
Variance        127      105        31     130     393
% Variance       15        4         2 Not Inc       6  (excludes losses)
Cost (P)         52       60        16 Not Inc     128  (excludes losses)


Adjusted       1003     2793      1276       0    5072       16 / 0.5
Variance        103      338        31     130     602  (includes losses)
% Variance       23       14         2       0      15  (includes losses)
Cost (P)         42      193        16      53     304  (losses at 41 p/
Adjusted status based on 22.5 knots Service Speed                litre)
Cost/Litre (p) assumed (Crank/Cyl/Aux Eng) = 41 / 57 / 52

CoMProg Ref 'MP1000PB.bas/P2/0282'
```

FIG. 2 Passage information printout obtained from the passage information form

Medium-speed main engine condition assessment

Checking of engine performance data received at regular intervals has been simplified with the aid of the microcomputer. For example, the engines of the vessels concerned ran at constant rev/min with CP propellers. The engine power, and hence the rate at which fuel was consumed, varied with the ship's speed, which depended on the propeller pitch setting.

The computer was used to find the mathematical relationships between power output and fuel consumption, based on engine test-bed readings; as well as important engine conditions such as fuel pump index, scavenge air temperature and pressure, exhaust temperatures and turbocharger revs/min. The program embodied all these relationships and enabled individual values to be predicted over the range 20% to 110% of engine rated power.

Engine condition was established by comparing the recorded temperatures, pressures, etc. with those derived by the computer from the daily fuel consumption. If significant discrepancies were noted, the range of information available was sufficient to predict the cause. To provide a permanent reference, a computer printout covering the whole operational power range was compiled as a booklet. Table I outlines a typical format from this. It is planned to develop the program so as to provide also automatic data input and storage for later use in trend studies; checks for values significantly outside limits, and an engine efficiency and thermal audit.

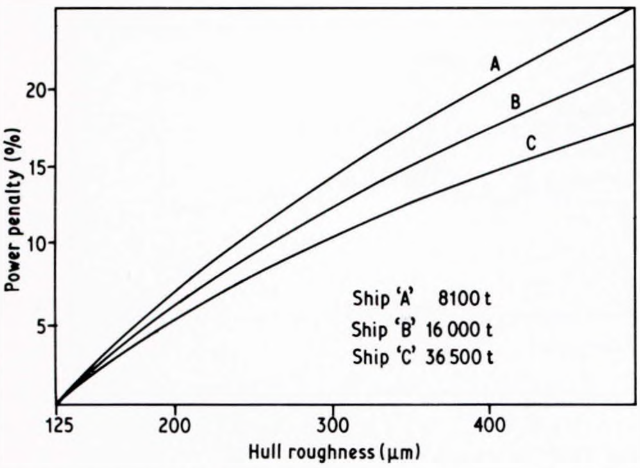
Table I: Predicted engine data for two daily fuel consumptions

40 t/day should equate to two engines at 5630, i.e. 11 260 SHP total	
Anticipated engine conditions:	
Maximum cylinder pressure	98 kg/cm²
Exhaust temperature (after cylinder)	381°C
Turbo-blower rev/min	13 184 rev/min
Scavenge air pressure	0.853 kg/cm²
Scavenge air temperature	35°C
Fuel pump index	35 mm
Exhaust temperature before turbo-blower	463°C
Exhaust temperature after turbo-blower	303°C
40.5 t/day should equate to two engines at 5701, i.e. 11 402 SHP total	
Anticipated engine conditions:	
Maximum cylinder pressure	99 kg/cm²
Exhaust temperature (after cylinder)	382°C
Turbo-blower rev/min	13 282 rev/min
Scavenge air pressure	0.871 kg/cm²
Scavenge air temperature	35°C
Fuel pump index	36 mm
Exhaust temperature before turbo-blower	465°C
Exhaust temperature after turbo-blower	303°C

Hull underwater surface roughness

Measurement and processing of roughness data

Since 1979, when a BSRA Hull Roughness Analyser was purchased, this subject has received considerable attention at Cunard. A substantial amount of roughness data, covering a wide range of vessel



(All curves based on 21.5 knots)

FIG. 3 Curves of hull roughness vs. percentage power penalty

types and paint systems, has been collected, almost all of which is now stored in computer files.

The BSRA machine's data printout for a typical roughness survey consists of upwards of 1000, generally three-digit, numbers that need to be added together to obtain average values for specific groups. Unlike a desk calculator, the computer enables every individual roughness reading, together with other pertinent data, to be permanently stored. A library of special programs automatically provides a complete set of useful and easy-to-comprehend information.

Typical examples include semi-pictorial displays of localized and overall values of hull roughness; values of sample standard deviation at specific locations; localized and overall values of paint dry-film thickness; localized percentage variation of paint dry-film thickness; percentage frequency histograms of roughness samples; and cumulative frequency curves of the roughness of samples.

One program enables the cumulative frequency curves for two separate groups of roughness data to be displayed simultaneously. Small differences in their relative numerical characteristics—such as occur when comparing overall surface profile roughnesses of successive coats of underwater paint—are highlighted when using this format. Factors such as substandard paint application, change in surface profile by paints designed to polish in service, and the rate of natural deterioration of various paint systems, can now be compared on a common basis.

Propulsive power penalties

The computer can predict the power penalty for any vessel operating at a particular speed and draft, using the relationship between surface roughness and frictional resistance. The financial implications of a variety of strategies, together with associated payback periods, can be calculated using a simple program.

Whilst many aspects related to hull roughness need to be more fully understood, in most instances there is enough information to determine the correct general policy for a particular set of circumstances.

The effect of increased hull friction on the propulsive plant can be included. Apart from increasing fuel consumption, with fixed pitch propeller installations, the rev/min/torque relationship can be significantly changed on account of this. It is usual to expect the ship's frictional resistance to increase over her life, and an allowance for this is made in the design of the propeller. When the propeller is driven by a slow-speed diesel engine, it is possible to encounter increases in frictional resistance that modify the rev/min/torque relationship to the extent that the engine becomes thermally overloaded. The program can be made to determine how much of this allowance has been lost in any particular set of operating conditions.

Figure 3 depicts a variety of computer-derived curves of percentage power penalties, plotted against average hull roughness values. It can be seen that, for the same numerical value of hull roughness, the effect is different for each size of vessel type shown; and that the percentage power penalty increases as the size of the vessel decreases.

Relative hull and propulsive plant performance

One of the methods currently used utilizes a 'coefficient of hull performance', defined as the ratio of speed achieved to speed anticipated. Whilst an over-simplification, this concept gives useful and fairly consistent results. Furthermore, the effort involved in data recording and processing is minimal.

Initially, the relationship between the ship's speed through the water and propeller revs/min is determined from new-ship trials data. The datum curve shown in Fig. 4 is for a specific draft and was derived from the foregoing. The relationship between revs/min and fuel consumption in tonnes/day was also derived for this draft. The symbols '*R*' for propeller revs/min, '*S*' for ship speed through the water, and '*F*' for tonnes of fuel consumed per day have been used.

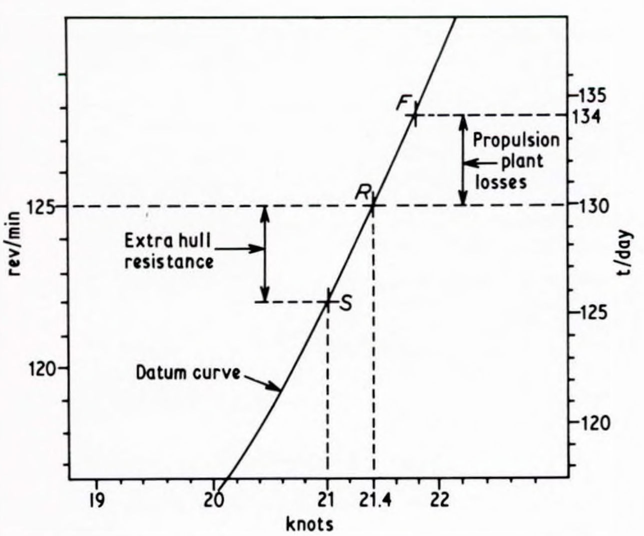
When the ship is at this draft and performing 'as new', the actual revs/min, ship's speed and daily fuel consumption are plotted, and will all coincide at the same point on the datum curve. On the assumption that the propeller efficiency varies less in service than either the propulsive plant or the hull, changes in overall performance of the two latter are monitored.

When the hull becomes rough or fouled, the in-service revs/min and ship's speed values, plotted on the datum curve, will not coincide. The difference that separates them, measured along the datum curve, provides a measure of the reduction in performance.

Similarly, when the propulsive plant overall efficiency falls, the revs/min and daily fuel consumption values plotted on the datum curve will not coincide. Again, the difference measured along the curve provides a measure of this reduction.

A computer program has been written which, when actual service data comprising ship's speed, draft, propeller revs/min and total daily fuel consumption are inputted, automatically provides values of relative hull and propulsive plant performance. If there is a difference between the service data draft and that for which the datum curve applies, the program automatically adjusts for this in the computations. This technique is used for assessments based upon single-day data.

To compare performance over a longer period, the form shown in Fig. 5 is used. The computer is programmed to provide such a printout and to determine rates of performance deterioration, when applicable.



	rev/min	knots	t/day
Actual:	125	21	134
Predicted:	125	21.4	130

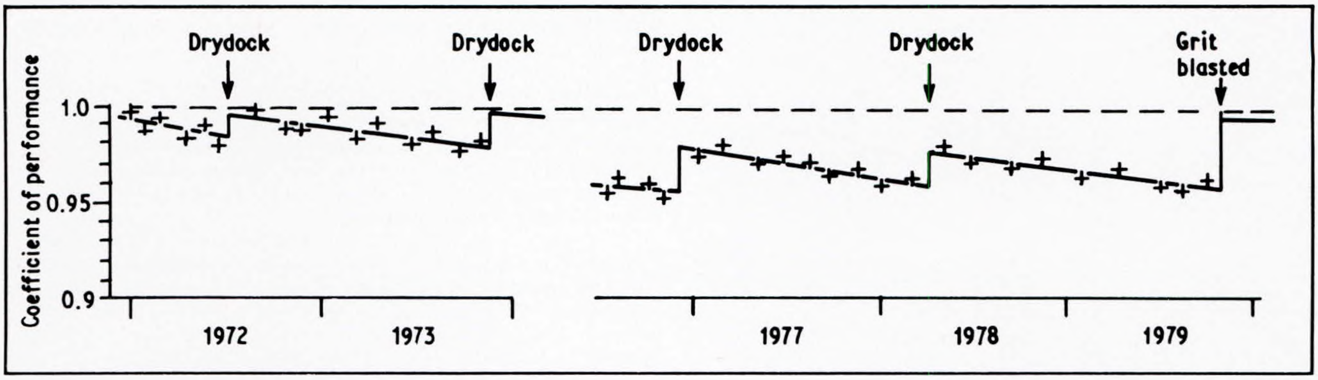
Hence: Hull performance = 21/21.4 = 0.9

Propulsive performance = 130/140 = 0.97

FIG. 4 Relative hull and propulsive plant performance

Planned maintenance system (PMS)

The practicability of recording and processing PMS data has been studied. The microcomputer is capable of handling this but the exact framework for such a system is still under discussion. Random access file handling techniques will be used, as they will enable large files to be searched quickly and entries to be updated. It is also relatively easy to modify an existing file structure, or generate a new type, and to transfer existing data directly into it.



(NB Coefficient of performance = achieved speed/actual speed)

FIG. 5 Relative hull performance: October 1971 to March 1981

Often, subsidiary files are generated just to extract particular types of information held in a larger and more general type of file. In a system proposed by the author, true planned maintenance tasks are separated from those usually performed as part of routine or watch-keeping duties; checks on, and topping up of, oil levels, cleaning of strainers, etc. being defined as routine tasks.

The second level in the system includes tasks such as oil and filter element changes, minor adjustments and, where applicable, implementation of a standard method of assessing the particular unit's performance. Dependent upon the results obtained, it can be decided whether or not to deviate from the basic maintenance overhaul schedule, or maybe defer, or bring forward, appropriate maintenance tasks.

The third and final level of the system comprises true planned maintenance tasks, i.e. removal or renewal of running components.

The computer can print out details of maintenance tasks that are either overdue, or will become due in one, two or three months' time, as well as relating the schedule to that of the classification society's survey cycle, if appropriate. Other information can be outputted, such as predicted work-loads and items requiring excessive attention.

Fleet spare gear stock control and audit

Similar records to those at present kept in ledgers can be stored on the computer. A program has been developed which enables all of the information to be stored, plus a range of file processing options. The computer displays a 'menu' of options, which the operator can choose from. Dependent upon the option chosen, the computer automatically proceeds, only calling on the operator if more information is required.

The menu includes options to modify or delete an existing file record; add a new record; search for a particular item by name or reference; search for, and extract, specific groups of items; print out every item with associated details; and audit the printout, i.e. list items, number off, total and cumulative value.

The computer generates a subsidiary file, in which any modifications, additions or deletions made to the the main file are automatically stored. Not only does this provide a record of all changes to the file but it is a useful check for errors. A further feature is that, each time the main file is updated, a hard copy is automatically produced which lists details of current changes to the main file.

Whilst our program was written specially to suit an existing system, a variety of standard stock-control programs automatically check on stock levels and indicate re-order quantities. They can be readily purchased for most microcomputer systems.

Data files storage and retrieval

This aspect of computers is important and can be exploited in many ways. Large commercial computers are often used as data banks. The microcomputer system can provide a similar, but obviously much more limited, facility.

The data storage units currently offering the greatest capacity are mini-Winchester hard-disk drives. Each can store, or provide fast access to, upwards of 2.5M individual characters (letters or digits). This facility can be included in a microcomputer system currently costing approximately £4000.

The most commonly used means of storing data on business systems is by using floppy disk drives. Up to four such units are often used. Interchangeable diskettes are used in conjunction with these drives and the storage capacity of each diskette varies from approximately 100 000 to 500 000 characters. Transfer of data to and from these units is also fast.

Cheaper microcomputer systems rely on standard cassette recorders for storing data. Whilst inexpensive, data transfer speed is typically one thousand times slower than that of floppy disks and data can only be stored in sequential files; this is a major limitation as random access files are used for many data processing applications.

To refer to, or store, any type of data on a microcomputer is simple. Re-naming, modifying, adding to, or subtracting from files, merging them with others or simply erasing them, all need little effort. The system rapidly attends to everything necessary, as well as keeping stock of the amount of content in each file and the remaining storage space available on the diskette.

Files can also be displayed on a VDU or printed out. Space requirements are very small, even allowing for master and back-up diskettes.

A variety of computer software is available which enables non-expert users to create their own files, store, amend, sort and search for information, purely by following simple instructions displayed on the VDU.

Word processing

Computers can be programmed to manipulate text as well as numbers. A word processor is a computer specially programmed to operate on text. Usually, this is its only purpose. To make it more convenient and efficient, its typewriter-style keyboard is provided with additional keys for commands frequently used by the operator. It is the most 'human-orientated' form of computer, as it is basically a sophisticated typewriter.

Most microcomputers can be used as word processors, simply by loading them with a program designed for this purpose. Whilst they are not as versatile or convenient to operate as a purpose-built machine, most of the more frequently used functions are available. This has been found extremely useful in the production of standard letters, drydocking specifications and reports. Apart from a very fast printout of the final text, the following facilities are available:

- Deletion or transfer or words, or blocks of text, defined by the operator.
- Automatic search for, or substitution of, words.
- Merging text from different files.
- Automatic references to files and production of mail lists, etc.
- Definition of print format, including pagination and justification, by operator.

Similar to numeric data, files consisting of text can be saved and retrieved from computer disk files.

The word processor facility was used to develop, store and alter the text for this paper.

Stock mathematical and statistical programs

Programs that can be used to solve commonly encountered mathematical and statistical problems have been found very useful. Calculations can be completed in a fraction of the time required by other means, with the added advantage that a hard-copy record of both the input and derived data is automatically provided.

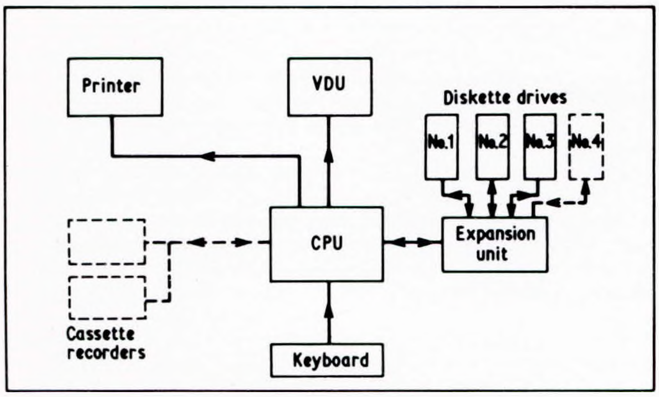


FIG. 6 Block diagram of the system

A library of such programs stored on a diskette is easy to obtain or they can be copy-typed from many of the books available and then stored on a diskette. Where sufficient expertise exists, they can often be embodied in a program being developed to fulfil a specific need. Typical programs accumulated enable the user to handle, quickly and accurately, the following topics:

- Automatic sorting of lists of numeric and alpha numeric data, in ascending or descending order.
- Plotting groups of x and y co-ordinates.
- Solving linear, multiple linear and n th order mathematical regressions.
- Testing sample distributions (statistical).
- Solving linear programming problems.
- Solution of common mathematical and engineering equations.
- Linear and curvilinear interpolation.
- Determination of difference in days between any two dates.
- Automatic x and y plotting of mathematical functions (up to ten simultaneously).
- A variety of financial computations (payback period, etc.).
- Automatic function determination from known group of x and y co-ordinates.

Extension of applications

On site

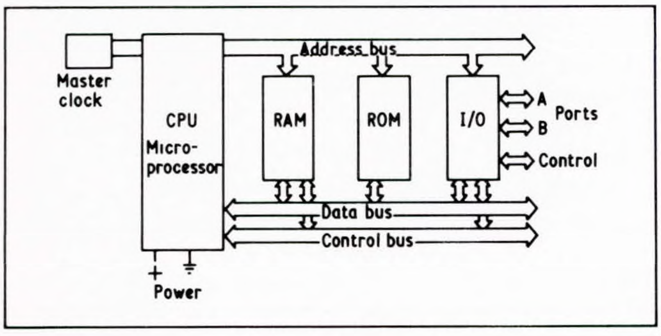
Although the system was obtained for use at head office, it is portable and can be taken to a drydock. Several thousand hull roughness readings obtained can then be processed immediately and used for decisions on whether or not to grit-blast the hull.

The basic equipment which is taken to the dock consists of a microprocessor, a VDU, a standard domestic cassette tape recorder and an optional printer. On return to head office, the readings are transferred from the cassette on to a floppy diskette for permanent storage.

Onboard ship

As data to be processed originate from the ship, there is a strong argument for installing similar equipment onboard, although not all uses for the information are common to both head office and the ship. There is, however, great scope for rationalization in the area of reports, stores, spare gear, defects, repair lists, planned maintenance, distance learning and onboard training.

FIG. 7 Central processing unit



This last item is being investigated by several shipping companies, as the computer can provide interactive, as opposed to passive, training and the supervisor can easily see when the student does not understand the subject. It is also possible to simulate damage control and fire-fighting exercises of an advanced type.

Information can be transferred easily between ship and head office by posting a floppy diskette; and transmission via satellite is now possible.

Equipment that operates satisfactorily ashore does not always do so afloat, and will have to be protected from power supply fluctuations and stray electromagnetic fields. However, existing equipment is as rugged as similar equipment already at sea and little marinization would appear to be necessary.

SYSTEM DESCRIPTION

Figure 6 shows a block diagram of our system, which consists of a central processing unit (CPU) and a number of peripheral devices which fulfil specific purposes. These are classed as 'input' or 'output' devices, depending on whether they transmit or receive information.

The CPU, as its name implies, controls and co-ordinates the whole system, and hence all input and output devices are directly connected to it.

The keyboard is an input device provided to enable the user to communicate with the CPU. It is used to enter commands and data into the computer. The keys conform with the standard 'qwerty' layout. In addition to a 'shift key', a 'graphic' and a 'control key' are provided. These enable many of the keys to be used to select five different types of character, i.e. upper case, lower case, pre-defined or user-defined graphic, or standard teletype and computer terminal functions.

The VDU is used to let the operator see what is happening inside the system. Every time a key is depressed, the equivalent character is simultaneously displayed on the screen. Apart from this, it is used for displaying lists of programs held in computer memory; text or data being entered; directories of files read from diskette drives; graphic output; and data derived from computations.

The printer is an output device, and its only purpose is to provide a permanent record of what can be displayed on the VDU.

The expansion unit provides both additional input and output facilities associated with the CPU. Not all systems include this unit, as its main purpose is to provide a convenient way of interfacing the system with a variety of peripheral devices not normally associated with an office system. Currently, it is only being used to house the diskette-drive master controller circuit board and connect the drives with the CPU.

The diskette drive units are also input and output devices, used for permanent storage and subsequent retrieval of computer files or programs. These allow large amounts of data to be transferred quickly between the computer's random access memory and different diskette drive units connected with the system.

The cassette recorders can also be used for permanent storage and retrieval of data and programs. The facilities they offer are much more limited than those provided by the diskette drive units, particularly with regard to data transfer speed.

Figure 7 outlines a typical CPU which normally is connected to the following components. The clock circuit produces an accurate master timing pulse for the system, typically at 12.368 MHz. This is divided and used for synchronizing other circuits, including the CPU, which contains all of the basic system logic that is required to control and enable the system to operate as a total unit.

Control, data and address buses provide digital communication paths between the CPU and associated devices. Each bus consists of groups of parallel lines. Control and data buses generally have eight parallel lines, and address buses 16.

The random access memory (RAM) can either be written to or read from. It is used as internal temporary storage computer memory. The read-only memory (ROM) can only be read from. It is used to store system control functions which are held in this memory permanently.

The input/output device (I/O) enables the CPU to receive or transmit information to peripheral devices, e.g. the keyboard or VDU.

Computer programs and operating staff

When the system was installed, only a nominal amount of computer software was purchased as it was intended that all programs would be developed in the technical department. This comprised a CP/M version 1.42/3 operating system; Microsoft BASIC-80 version 5.1, and a word processor package (all on diskettes).

BASIC-80 is a high-level language, i.e. user — as opposed to machine — orientated. BASIC has become the standard microcomputer language and is available on many large computers. Its name is derived from the words 'beginners all symbolic instruction code' and comprises approximately 100 logically-named reserved words or commands that can be used individually, or strung together, to instruct the computer to perform specific tasks.

BASIC is easy to use by non-specialists: usually they are capable of writing simple types of program after a relatively short period of time. It has its own form of syntax and, if a program does not comply, when run, the computer automatically stops and displays an appropriate syntax error message on the VDU. This feature simplifies debugging of programs.

On applications requiring special software, system users who can write programs have an advantage over those who cannot. Specially written software is expensive. However, the range of relatively inexpensive software, designed to be easily modified by any system operator to suit specific requirements, is increasing rapidly. It is possible to purchase software that, reputedly, allows an inexperienced operator to write a wide range of programs.

It is often difficult to predict accurately the cost of writing and debugging one's own programs; obviously the potential savings in computerizing a task must provide sufficient margins for this. As a rough guide, the initial effort to write and check a program can be 100 times as great as that of manually performing the task it fulfils. However, the program enables the task to be performed much more quickly and with consistent accuracy. Furthermore, it can enable tasks to be performed by staff who otherwise may not have the necessary knowledge or understanding.

The following types of staff are directly involved with the system. The author has overall responsibility, and develops programs and applications for assessment. A technical assistant keeps computer files and records up to date and produces 'back-up' diskettes. Technical secretaries enter and store data, load and run programs, and obtain printouts.

With the exception of my own role, all of the staff involved are capable of performing all of the duties required. None had previous computer experience and none has found the system difficult to use. Regarding familiarization time, experience with students obtaining work experience shows that, in less than three days after being given a little instruction, they are capable of performing a variety of useful tasks, using the system.

Installation, maintenance and reliability

A 250 V, 50 Hz, 250 W power supply is required. The whole system can be installed on any convenient desk top. It is located so that the VDU does not face brightly-lit areas and the operator is not subjected to any distractions. Only when the printer is operating does the system generate significant noise.

Its maintenance requirements are negligible. It is anticipated that it will operate for at least three years before any major servicing is required, this being confined to mechanical components of printer and diskette-drive. Table II indicates component life expectancies of items prone to mechanical wear.

Maintenance contracts costing annually between 10 and 15% of the hardware cost are available. As any defective parts discovered in the first year were covered by guarantee, and 100% availability of the system was not essential, no maintenance contracts are currently considered necessary by Cunard.

Any substandard electronic component in the system is most likely to fail during the first few hours of operation. Once it has operated satisfactorily for approximately 100 hours, a high degree of reliability can be safely assumed.

Power supply fluctuations can adversely affect the system, even though it has an integral mains filter. Whilst it can tolerate wide fluctuations in supply voltage and frequency, substantial mains supply transient voltage peaks or short breaks can cause the system to 'crash' and indicate a fault. Normally these do not damage the system physically.

Several types of specifically designed mains filter units are available. Since we fitted one of these, no system 'crashes' have occurred.

SELECTION OF MICROCOMPUTER SYSTEMS

A wide choice of competitively priced equipment is available. Provided it is known what applications are envisaged, any reputable equipment supplier could propose a variety of equally suitable systems. Even though the equipment carries a one year guarantee, the choice of the supplier is important. It is usual to pass through a familiarization phase when any latent faults usually show up, normally within 90 hours' operation, and problems purely due to operator ignorance can arise. The importance of having easy access to a true expert cannot be overstressed.

Microcomputers are provided with two types of memory. ROM (read only memory) is permanently encoded and cannot be changed. The other type, RAM (read/write random access memory), provides temporary storage for program instructions and data and its capacity is important. Every character or digit stored requires 1 byte of memory; a minimum of 48 000 bytes of RAM is considered necessary for our purposes.

The microcomputer keyboard enables the operator to control the system and input data. A full-size standard qwerty layout is desirable. The inclusion of a 16-key numerics pad enables numerical data to be entered more quickly and accurately. Upper and lower case characters should be provided; otherwise, word processing applications are severely limited.

A high-resolution black and white VDU with a 12-in screen has been found to be satisfactory. Preferably, the system should allow either 64 columns by 30 lines, or 80 columns by 24 lines of text to be displayed simultaneously, i.e. 1920 characters in all. High-resolution graphical displays, either black and white or coloured, have become a standard microcomputer feature. Dot matrix printers capable of printing in seven colours are now available.

Dual diskette-drives provide a satisfactory arrangement for mass storage of data, etc.; those providing approximately 300 000 to 500 000 bytes capacity being preferred. Apart from offering better cost/capacity ratios, they provide a more flexible system and fewer diskettes are required. A system can be run with only one drive but processes such as transferring data from different diskettes or making back-up copies are tedious.

The quality of the electromechanical drives and of the diskettes is important as they are designed to operate within fine mechanical tolerances. Any significant wear requires them to be readjusted, otherwise system performance is degraded.

Regarding printers, there are two basic types of application. When speed is more important than quality, a dot matrix printer is generally used. Many types are available and one with the following features is considered suitable:

Print at least 100 characters/second.
Upper and lower case characters; preferably with descenders.
Switchable to either 40, 80 or 132 columns on A4 paper width.
Can use ordinary paper either in sheet or continuous form with sprocket feed.
Simultaneous output of up to three copies.

This type of machine can often print graphic characters, thereby enabling VDU screen graphics to be put out on hard copy.

When quality print is necessary, a daisywheel or thimble printer is used. With these precision printers, a wide range of print wheels or thimbles can be used to change print size or typeface; graphic characters are not available, though. Printing speed varies from 25 to 60 characters/s and they generally accept paper approximately 15 in wide, using sprocket or friction paper feed. They are more expensive than dot matrix printers.

It is important to establish how much a system can be expanded and how easily it can communicate with new and improved peripheral equipment. In better microcomputers, interface facilities are built in.

Table II: Expected life of mechanical components

COMPONENT	EXPECTED LIFE
Printer:	
Dot matrix printing head	100M characters
Diskette drive unit:	
MTBF complete unit	8500 h running
Read/write head	10 000 h running
Diskette	3M rotations = 166 h running

These consist of circuitry and enable external devices to be selected and compatible signals to be exchanged. They may use serial or parallel input/output, and commonly used standards are the RS 232, S-100 and IEEE 488. As an example, the RS 232 interface enables two computers to communicate via the public telephone network.

Interchangeability of computer programs between one system and another is very desirable. System-operating software enables the user to communicate and control all the system and allocates available resources efficiently. Every microcomputer has its own operating software, usually stored on ROM. More powerful operating software can be stored on floppy diskettes, read into the computer's memory and used instead of its own operating software.

Unfortunately, the makers of several of the more popular microcomputers have each developed their own operating software which is not interchangeable. However, a well-established system called CP/M by Digital Research is widely used on mini- and microcomputers. Its popularity is such that almost all makes of system with floppy diskettes can use it. This means that two different types of system can interchange computer programs and a wider range of software is available.

CONCLUSIONS

The microcomputer system was found easy to use, reliable, extremely versatile and cost-effective. Apart from being suitable for a wide range of tasks, it can rapidly switch between these. However, a 'batch' type processing policy is followed whenever possible.

Compared with totally manual methods, data can be processed more accurately and much faster; also, information derived can be automatically printed out. This enables those concerned with management, policy- or decision-making to receive the latest information sooner.

It has already been concluded that the system will play an increasingly important role in the Department. A variety of new, as well as existing, tasks are planned; for instance, a method in which data produced by the hull roughness machine can be directly input into the computer, for automatic processing, has already been partially developed.

Microcomputers are becoming increasingly 'user-oriented' and their rate of technical development is impressive. Apart from new commercial software suppliers, a growing number of other people are gaining programming expertise. Therefore, a wide variety of additional software should be available soon. Current systems, and those obtained in the immediate future, will continue to represent increasing value for money.

Generally, when computer programs are run, the system operator only needs to type in answers to requests for specific information, displayed automatically on the VDU. This can enable tasks to be performed by those who otherwise may not have the knowledge or understanding to fulfil these. Furthermore, suitable programs can minimize time consumed in performing mundane and repetitive tasks, and allow staff to use the time saved for other activities.

Although some benefit was obtained shortly after installation of the system, much of the initial time and effort associated with development and familiarization was considered to be a form of investment for the immediate future. Utilization of the potential offered by microcomputers will be limited by the rate at which knowledge and acceptance of them is gained. Those quick to realize and master their potential will have a significant advantage over those who have not.

ACKNOWLEDGEMENT

Formal thanks are made to Liveport Data Products for their assistance and the information supplied, particularly in the early stages of our project.

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APPENDIX 1. GLOSSARY OF TERMS DEFINITIONS AND ABBREVIATIONS

ASCII — American Standard Code for Information Interchange, representing letters, numbers, etc. by the 128 permutations of a 7-bit code.

BASIC-80 — Most extensive version of the high-level language BASIC available for Intel 8080 and Zilog Z80 based microcomputers.

Baud rate — Data transmission rate for an asynchronous word; the data rate of the individual bits within the single word.

Bit — A binary digit. The smallest unit of data in a digital system or a microprocessor.

Bug — An error in a program that causes the program to do something the programmer did not design it to do.

Bus — A digital communications path between a microprocessor and other associated devices. The bus generally carries bidirectional data or unidirectional address information. Buses normally have 4, 8, 12, or 16 parallel lines each carrying 1 bit of a 4, 8, 12, or 16 bit word.

Byte — A digital number consisting of 8 bits.

Clock — A pulse generator giving the microprocessor, memory, and I/O devices common timing signals. Clocks are usually single or two phase.

CP/M (control program/monitor) — System operating software particularly suited for Intel 8080 and Zilog Z80 based microcomputers and IBM-compatible flexible disk back-up storage. It is the most widely-used operating system and is considered the standard for microcomputers. CP/M is a trade mark of Digital Research.

CPU (central processing unit) — All the microprocessor logic, including registers, arithmetic logic unit, timing and control circuitry.

Daisywheel printer — A serial precision printer. The printing mechanism is similar to a daisy-head, each petal tip having a single character attached.

Data — A general term referring to the information passed through a data processing system. Data, as opposed to program.

Debug — The procedure of running a program and correcting errors (bugs) in the program.

Dot matrix printer — A high-speed printer which has a rectangular matrix of magnetically actuated pins; characters formed by appropriate combinations being activated simultaneously.

File — An organized collection of data of a specific length and size, stored in either external or internal storage.

Floppy diskettes — A flexible rotating mass storage device using an 8 in or 5.25 in diameter piece of magnetic material contained in a non-removable protective envelope. Floppy diskettes typically hold between 100 000 and 500 000 bytes.

Hardware — The electronic and electromechanical parts of a computer as opposed to the software programs.

High-level language — A computer language using English words, decimal arithmetic and common algebraic expressions. Each line or statement represents a large number of computer operations.

Input — Data or programs received by a computer from some external source. Input normally refers to an input to the computer while output refers to an output from the computer.

Instruction — An individual unit of a program. Programs normally run one instruction at a time.

Interface — The circuits necessary to connect the microprocessor to some given device. The device may be memory or input/output devices. Interfacing is a general term for interconnecting electronic devices.

I/O — Input/output of information in a computer system.

Language — A set of characters, conventions and rules that is used for conveying information.

Mass storage — Storage external to the main microprocessor memory and generally capable of holding many times the capacity of the central processing unit RAM.

Memory — Where data or programs are stored in a computer or peripherals for a later use.

Microcomputer — An entire computer system built using a microprocessor as the central processing unit.

Microprocessor — An integrated circuit (usually large-scale integration) which performs all the functions normally found in a digital computer central processing unit.

MTBF — Mean time between failures.

Parallel — Moving a digital word from one place to another where all bits comprising the word are moved simultaneously.

Peripheral — A device such as a printer or mass storage unit which is an accessory to a microprocessor or microcomputer.

Port — The physical communication line between the CPU and a peripheral. Each port has a numerical address that the CPU uses in communicating through it.

Program — A list or schedule specifying actions for execution by a computer.

QWERTY — Standard typewriter layout of characters on keyboard.

Random access file — A file having a structure such that the time taken to extract data held in any part of it is constant and fast.

RAM (random access memory) — The common term used for read/write memory, i.e. memory that can be both written into or read from directly by the computer.

Read — Retrieving data from a memory or I/O location.

ROM (read only memory) — A memory device which contains a permanent set of digital words. It cannot be written into.

RS-232 — A standard protocol for serial communication between computers and peripheral devices.

Sequential file — A file having a structure such that data is stored in the sequence entered and can only be accessed in the same order; data access time varies with its location in the file.

Serial — A method of transmitting data words one bit at a time, rather than the entire word over multiple lines.

Software — All the programs and programming information supporting a microprocessor.

System — A complete, integrated and functional computer made up of various hardware components linked harmoniously together and unified by software-programmed intelligence.

S-100 — The CPU bus comprises data transfer, addressing and control lines; there is no standard CPU bus. However, the Altair 8800 CPU bus structure has been adopted by a variety of manufacturers and is the most widely used type for microcomputers. It is also known as the S-100 bus and may be considered the *de facto* standard.

Winchester drive — A mass data storage unit frequently used in microcomputers. Typically, it consists of several rigid disks having a magnetic coating on their surfaces and which rotate at high speed. Unlike floppy diskette drives, the read/write heads do not come in contact with the magnetic coatings. Storage capacity is upwards of 5M bytes.

APPENDIX 2. MICROCOMPUTER SPECIFICATION

The general technical description and facilities provided by the system used are as follows:

- Central processing unit (CPU) 8-bit, Zilog Z80 type. CPU clock rate 2.1M Hz.
- 48K bytes of random access memory (RAM).
- 4K resident CPU ROM.
- 63-key standard typewriter size 'qwerty' layout keyboard complete with 16-key numeric pad.
- Dual cassette input/output facility with remote control (data transfer rate switchable to 300 or 1200 baud).
- RS-232 serial input/output port.
- Parallel data port.
- S-100 connection port and S-100 expansion unit with 6-slot capacity.
- Video display of 64 characters/line, and 30 lines/screen, 240 x 512 dot VDU graphic resolution, professional video monitor connection.
- 3 x 315K bytes (formatted) double density hard sectored 5.25 - in diameter floppy diskette drives (system can support a total of four drives).
- Dot matrix printer (112-characters/second and switchable to 40, 80 or 132 characters/line, line feed switchable to 6 or 8 lines/inch.

Discussion

D. J. MOTTRAM FIMarE: The author has presented a very good paper which will be of interest to all shipping companies. He and his company seem to have achieved a great deal during their first year's experience.

One immediate thought is that an early syndrome of computer systems was the need to renew completely the company paperwork. This does not seem to have been the case here and the paper demonstrates that independence of attitude can be maintained within a company when tedious data-handling processes are computerized, without changing the preferred method.

Voyage technical data storage on computer files is obviously of great advantage and assessment by computerized techniques will allow, as the author says, staff to use the time saved for other activities. Perhaps it is more than this though; perhaps this assessment and, more importantly, the next development stage, i.e. trend analysis, are better done by computerized techniques.

Furthermore, when passage information input 'error trapping' is developed sufficiently, and mathematical models for all types of ships and power plants are fully developed together with machinery condition monitoring techniques, very little output will be required. We do not need to know about things that are operating correctly, we need only for the output to highlight those areas of inefficiency or areas of imminent breakdown.

Does the author envisage that the system will develop along these lines and does he expect that all the discrete programs, as developed, will ultimately combine into one overall ship program?

Perhaps an important item in any new system is developing enthusiasm. Operator familiarity tends to breed enthusiasm which then generates interest from other people. Has the author found this to be the case during this first year within his department?

It is interesting to speculate whether the system will ultimately be on board each ship. At present, all input and output information is done in head office with historical data. The author says that installation on board is currently not planned. Presumably with the advent of faster and cheaper communication, and since the system is of very low cost, it will be both on board and in head office with full instant intercommunication. How would the author see future development?

Taking this on-board development one stage further, a total dependance of a ship on such a system is a debatable exercise and hard copies must be produced and kept. If the system is to be installed onboard, how does the author envisage such a system being operated on a ship which can revert to manual processing in the event of failure or loss of records?

A disadvantage at present is that (as pointed out) the systems are not interchangeable between makes and progress in development is hindered where a change of model is required. This paper demonstrates a need to lobby for standards in the microcomputer system which would enable complete interchange.

Finally, in the view of the first year's experience, if a fresh start could be made would the author have preferred a mainframe system with multi-user access rather than a collection of microcomputers?

T. W. BUNYAN FEng, FIMarE: The estimate of the performance of a ship in service given in the paper relies on sampling hull roughness, etc.; i.e. an indirect method which may or may not give a result of sufficient overall accuracy on which to base vital decisions as to the time and to what extent re-conditioning of the hull, machinery and propeller blade surfaces is necessary to achieve a required result.

Much greater authority and confidence would be achieved if periodic checks were made: the equivalent of 'the measured mile' but at sea, with the advantage that ideal weather conditions and smooth ship movement can be chosen for the test, day or night.

The technique is based on the 'Ancient Mariner's' speed-measuring device, the Dutch log, with some modern sophistication, to give a ship's speed through the water to a very high degree of accuracy. The measuring technique, a quartz oscillator controlling a multi-channel digital display, was checked on the Road Research Laboratory's test track and found to be accurate with their own standard measurements to one-hundredth of a second at speeds of 10, 15, 20 and 25 miles/h.

In a VLCC this gives a speed measurement to an accuracy of ±0.08%. As far as I am aware, this is much more accurate than any commercially available equipment.

Simultaneous readings of rev/min, thrust and propeller torque would enable the entire picture of ship and machinery performance to be obtained. Where controllable-pitch (CP) propellers are employed, it would allow accurate matching of engine performance to the partly-fouled condition of the hull. It could also be used to indicate the much greater sensitivity of hull performance to surface roughening at certain critical parts of the underwater surfaces of the hull.

The 'Dutch log' technique described above has not been popular, probably due to the fact that two observers must be used but possibly also due to the erroneous idea that, because the observers use dummy sighting guns to follow a floating target, they must press the trigger to obtain a reading. There is, of course, no trigger and the digital counters are started and stopped automatically when, unknown to the two observers, the rotation of the gun passes the accurately pre-set position at precisely 90 deg to the hull axis.

A further sophistication is intended using lasers, thereby dispensing with the services of the two observers.

Reference

T. W. Bunyan, 'A shipowner's approach to some shafting machinery and hull problems'. *Europort Technical Congress,* 12 November 1971.

M. F. WINIBERG (Liveport Data Products Limited): Other uses of microcomputers relevant to shipping that are possible with today's technology are as follows.

One application is engine room control. Engine conditions are at present monitored by mechanical gauges and data loggers. The data collected could be fed to a computer so, instead of a large, difficult-to-view console area, a small screen can display all the functions monitored. Automatic notification, or even correction, of faults/changes in engine conditions (such as changes in lubrication pressure/temperature) can be made under the computer's control. The display of engine state can also be relayed to any part of the ship via cable.

As part of this task, the ship's running performance can be monitored and defects in equipment that develop during running can be checked and corrected for. There is also the possibility of tracing a fault before it becomes serious.

A similar application is the monitoring of hold/cargo conditions, again with the automatic correction of temperature/humidity changes and production of a log of the state of the cargo, at present produced by data loggers. The computer can simply print out the changes and corrections made, rather than the large quantity of printed but mostly unrequired data that is produced at present. At the same time, hot spots in the hold can be found quickly, and notified, and defects in monitoring equipment traced and allowed for.

Micros can be used onshore or aboard as part of a training scheme, simulating changes in ship's conditions to allow ship's officers to become familiar with the correct action to take in these circumstances, without the need to alter artificially the ship's running conditions.

In conclusion, the possible uses of microcomputers in the shipping industry are widespread: they are cheap, reliable and relatively easy to use. The major problem in introducing them is likely to be convincing people in management that they can perform these tasks without prejudice to their existing mainframe computer installations or staff — not an easy task!

D. C. WARKMAN (BP Shipping Limited): I should like to ask Mr Perry two questions, as follows.

First, the 48K random access memory (RAM) seems to be excessive for such a system. Would the author like to comment on this?

Second, would the author like to comment on his views regarding transferring more responsibility to the vessel itself, using a shipboard computer, rather than bringing all the data ashore to head office?

As Chairman of the meeting, I should like to point out that Mr Perry has highlighted two very interesting aspects of computers in the marine environment. One is that their capabilities and scope are so wide and varied that the first major task is to decide what to best utilize the computers for.

Second, there are probably few marine engineers who are familiar with the day-to-day operation of computers and it is a sobering thought that many very young schoolchildren are using them quite competently on a daily basis. Perhaps we have a lot of catching up to do!

Author's Reply

Mr Mottram's comment that existing company paperwork does not appear to have been affected by computerization is correct. To date, a policy of ensuring that all computer programs developed are completely compatible with existing company procedure and paperwork has been strictly adhered to. This enables direct comparisons to be made between existing and proposed methods, and demonstrates that the microcomputer is capable of imitating any existing method exactly, in a step-for-step manner.

It is considered worth mentioning that the studies required to quantify tasks that should be computerized also provide an opportunity to check that the existing methods are still the most appropriate for current needs. In certain cases, it became apparent that several different but related existing tasks could be usefully merged and rationalized.

I agree with Mr Mottram's comment regarding the importance of trend analysis. Some of the time saved by computerized assessment of voyage technical data is now used to produce more of this type of information.

Regarding computer information output, as stated by Mr Mottram, ideally only that which highlights areas of inefficiency or imminent breakdown is required. Whilst agreeing with him, at our current stage of development it is important that sufficient information is outputted not only to show clearly what functions the computer program is performing, but also to provide means to check that all of this is correct. Only when there is complete confidence in a program would I consider stripping it so as to only highlight apparently problematic areas.

Mr Mottram's reference to ultimately developing a wide range of discrete programs and combining these into one overall ship program is considered both logical and practical. Whilst most of the computer programs written to date are used separately, a deliberate corporate approach has figured in their development and relationship to each other. One reason that the interpretive form of the high-level programming language BASIC has been used is that it allows different computer programs to be easily merged with each other.

If a single overall ship program were used, its total size could amount to 100K or more bytes; this constitutes a large program. An 8-bit word size microcomputer system could be used but it would necessitate using techniques such as paged RAM or the diskette drives to increase effectively the system memory capacity.

With regard to enthusiasm for the system, this has increased steadily. Initially it was restricted to those directly involved in operating and developing the system, with the degree of enthusiasm being related to their level of competence in operating it. It then spread to other members of staff, both inside and outside the department, and increased in proportion with their improved understanding of how and what the system could be used for. This is encouraging since, as is common with most situations where major change or innovation is introduced, a degree of sceptism is normal.

Whether in due course a microcomputer system will be put on board our cargo fleet vessels is currently a matter of conjecture and the following comments only reflect my own views.

Pressures to reduce ship operating costs associated with ship and shore activities will increasingly strengthen the case for utilizing computerized techniques both on board and ashore. Regardless of the division of responsibility between ship and office, it is considered that the facilities required ashore and afloat would need to be generally similar and fully compatible. Ideally, data should be processed as soon as they become available, so that any action considered necessary can progress as soon as possible. As the ship is the source of most of the data, it would appear appropriate to provide onboard facilities to process this.

Concerning future development, those already developing or about to develop the potential offered by microcomputers will probably use popular systems based upon an 8-bit word size CPU. These could enable suitable applications to be developed and optimized very economically. Additionally, for those not already familiar with computers, they will provide a good insight into their uses and practical experience in operating them.

Several 16-bit word size microcomputers are now available; although more expensive, they are gaining popularity. They are more powerful, and suitable for supporting several users at a time. If combined with the advanced communication systems now available, a vessel could have a central onboard computer system and almost instant ship-to-shore or ship-to-ship communication/computing facilities. It is speculated that future development will move in this direction.

As far as total dependence of a ship on such systems is concerned, if indeed this did materialize, adequate arrangements in case of system failure would need to be provided. The importance attached to ensuring 100% system availability would influence what provisions should be made. Whilst likely to play an increasingly useful role, the system is seen mainly as a management tool and its non-availability more likely to cause inconvenience rather than jeopardizing the safety of the ship.

The problems associated with non-interchangeability of systems should diminish. Apart from a variety of software packages which enable transfer of information between different types of system, there are some signs of a greater degree of standardization. Advances in micro-electronics may produce new complications. Logically, acceptance and the degree of their use will depend on the overall advantage offered compared with alternatives existing at the time.

Concerning the question, 'If a fresh start was made would a mainframe system with multi-user access be preferred?', the mainframe and the microcomputer each have their own particular advantages. On reflection, I would still favour the microcomputer for the following reasons:

- The system is self-contained and completely portable.
- Computing capabilities and speed adequate and represents exceptional value for money.
- It is suitable for shipboard use.
- It has been found reliable and requires negligible maintenance.
- Installation and running costs are very small.
- It is predicted the popularity and growth in the use of 8- and 16-bit word size microcomputers will be substantial.

If the situation merited multi-user facilities, I would consider that a local network comprising several microcomputers sharing, say, a 20-megabyte capacity central hard disk storage unit would provide a powerful and cost-effective solution. Furthermore, there should be no problem in communicating with any modern type of mainframe computer if required.

I agree with Mr Bunyan's concept of simultaneously taking the necessary readings to derive a combined picture of hull and propulsive plant performance; also, speed measurement by the method described would appear to be accurate.

Speed is, however, only one of several variables involved in assessing performance, with the overall accuracy being determined by the combination of the accuracy of each of these.

It may be of interest to mention that the last three Cunard steamships built, now some years ago, automatically and continuously monitored the overall specific fuel oil consumption derived from simultaneous measurement of the appropriate variables.

Regarding the hull and propulsive plant performance assessment currently provided by the microcomputer, as stated, this is not claimed to be extremely accurate. However, it does provide a good indication of both of these parameters purely from basic passage data which are received as part of each vessel's standard reporting procedure.

The applications outlined by Mr Winiberg serve to show that the system can also be used for many other types of task other than performing general computations. The paper mainly dealt with applications in which data were originally entered via the computer keyboard.

The S-100 expansion unit, which was only briefly referred to in the paper, enables the microcomputer automatically to receive and transmit digital or analogue data from data loggers, communications or other electronic systems. This means it can easily be used as an intelligent extension of a basic data logger system, to provide condition monitoring facilities.

For example, diesel-engine exhaust temperatures could be continuously and automatically sampled, compared with expected values, and automatically printed out. Comparison of performance against established time-elapsed trends could often provide advance warning prior to reaching an alarm condition associated with either an individual or several cylinders.

The use of microcomputer-based training aids provides some exciting possibilities. This is already being developed in depth in at least one section of the UK marine industry, in the form of programmed learning with self-assessment, video and audio recording backing.

In reply to Mr Warkman's comment regarding the amount of random access memory (RAM), currently, the range of applications is generally related to the amount of RAM available.

In several important applications, not all of the RAM associated with the system remains available for program or data storage. This is the case when the system acts as a host for powerful versions of high-level languages, or word processor software packages that are loaded from storage on a floppy diskette into RAM. Typically, between 16K and 30K bytes of RAM are required for this purpose, so that a system with 48K RAM is effectively reduced to 32K and 18K respectively as far as the user is concerned.

Whilst there are programming techniques in which blocks of memory can be reused by over-laying, thereby artificially expanding memory capacity, it is now common for a system to have 64K RAM. The relative cost of memory is falling; currently, for an outlay varying between £50 and £100, 16K RAM expansion modules can be fitted to many popular types of microcomputer.

Now that the 16-bit microcomputer has arrived and its popularity is increasing, it should only be a matter of time before microcomputer systems having up to 256K RAM are not unusual. This will mean that, similar to a mainframe computer, memory capacity will cease to have the same significance that it currently has for the average microcomputer programmer or user.

Regarding Mr Warkman's comments on transferring more responsibility to the vessel, I have no strong feelings for or against. It would depend upon the type of vessel, where it operated and, most importantly, on the standard of ship management expertise and general attitude demonstrated by those on board. My main interest is in developing the most suitable means of enabling both ship and shore staff to obtain the information necessary to operate their vessels most efficiently.

As stated earlier, regardless of the division of responsibility between ship and office, it is considered that computerized techniques will become widely adopted and the facilities required ashore and afloat would need to be generally similar and fully compatible. Furthermore, expected developments in ship-to-shore communications will mean that the ship and office will cease to be remote.

Mr Warkman's comment regarding young schoolchildren using computers quite competently is considered very pertinent. The recent emphasis on computers in schools is encouraging. However, much similar work needs to be done, and quickly, in industry in general, so that the uses and benefits of using microcomputers are clearly appreciated. This applies not only to those who should directly use this technology so that they may improve their overall performance, but, more importantly at this time, it is imperative that those who dictate policy also have a clear appreciation of how and what such systems can usefully be used for.

As will be confirmed by those familiar with microcomputers, apart from providing some new and exciting possibilities in the field of computing, they constitute a very powerful tool that can be easily mastered by most people. This means that existing staff can become involved with any computerized techniques that are introduced.

In conclusion, I wish to thank those who contributed to the discussion and hope that the paper will generate some interest in a subject that, in due course, will have serious and far-reaching implications not only to ourselves but also to all sections of industry.

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