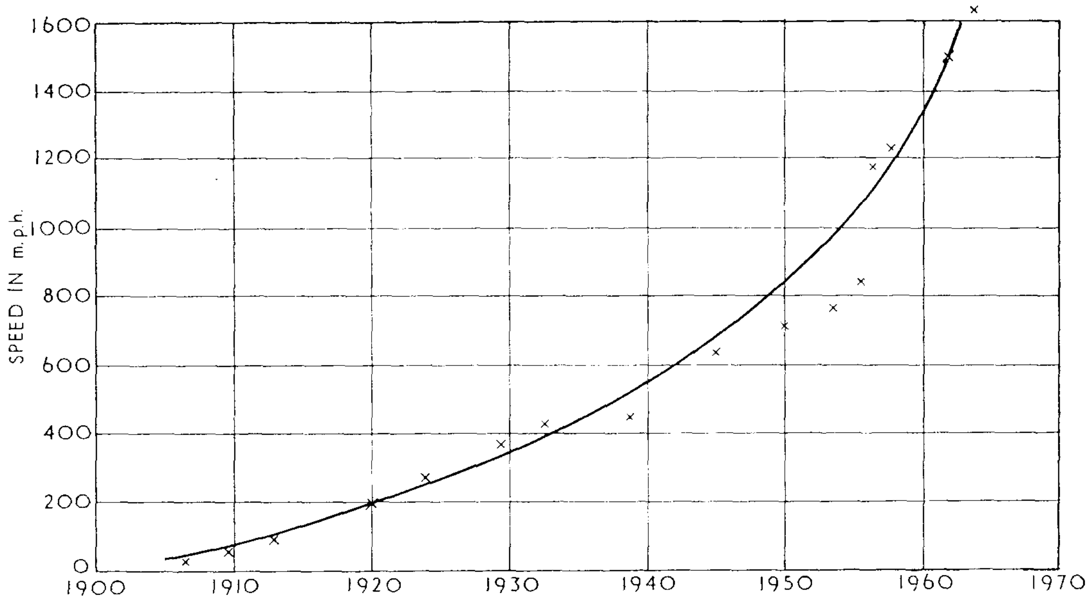

FIG. 1—AIR SPEED RECORD

MARINE ENGINEERING IN THE SPACE AGE NAVY

BY

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J. Lewis Powell in a notable lecture delivered in Ottawa* drew attention to the 'Collapse of Time'. In brief, he plotted a 'curve of technology'; and concluded that the progress made annually at the present time exceeds the progress made in all the centuries before—FIG. 1, showing the air speed records since aircraft began, illustrates this trend.

The present paper, which is a personal expression of opinion, seeks to apply this reasoning to problems affecting the Marine Engineering Profession in the Royal Navy, and to sketch the outlines of possible solutions.

Progress is Universal

It is easy to see progress in costly and exotic problems such as hypersonic aircraft, megatonic explosions and nuclear propulsion, but it is not so easy to appreciate the impact of change in more conventional fields even though, or perhaps because, the evidence is plain in every daily activity. Consider the equipment fitted in the average kitchen, and the types of tinned and frozen food stored in it; and list the items that were available at family budget prices in 1950. Consider the spread of television. Or consider two examples of direct concern to ships' officers: cases where heat exchanger tube plates are blocked by polythene garment wrappings are becoming increasingly common; and our present troubles with perforation of heat exchanger tubes are directly due to the staggering increase in pollution of estuarine waters that has taken place in the last few years.

*The Collapse of Time by J. Lewis Powell, J.N.E. Vol. 12, No. 1.

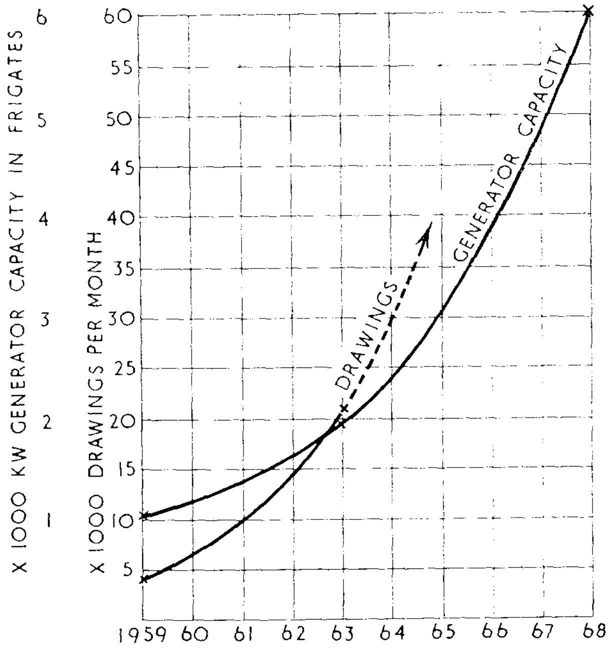

FIG. 2—(i) DRAWINGS PER MONTH PROCESSED BY T.R.B., BATH, FOR SHIP DEPARTMENT
(ii) ELECTRICAL GENERATING CAPACITY IN FRIGATES

Complexity of Warships

In the Ship Department the principal problem is the increased complexity of warships which is a direct result of general progress in technology. It is dramatically illustrated by the increase in the number of drawings processed for the Ship Department, which has risen fivefold in the last four years, though it is true that a part of the increase is due to the development of drawing practice. Since the number of professional and technical officers in the department has fallen by about 4 per cent during the same period, it can be concluded that less time is devoted to each drawing and less time is available for study of specific problems, with consequences that have yet to be evaluated.

The reasons for this increase are not hard to find. In 1959 the installed electrical capacity in frigates joining the Fleet was 1100 kW; today it is 1900 kW; and for the immediate future 6000 kW is being considered. The power demand rises because more, and more complex, equipment is being fitted; not counting free standing air conditioning units and the like, D.M.E. is installing 27 more machines in the latest version of the Type 12 frigate than in the original design, and there are incidentally no fewer than fifteen different requirements for compressed air at varying pressures from four thousand down to one pound per square inch. The monthly flow of drawings in the Ship Department, and the generating capacity in frigates are shown graphically in FIG. 2.

There is not any direct relationship between electric load and complexity, though clearly one reflects the other. The complexity cannot be denied, and it seems probable that if the number of components in a system be, say, doubled, then the difficulty of designing it and setting it to work will be more than doubled. It is to be hoped that because of progress in design the chance of failure and the difficulty of maintenance will not be greatly increased; but it seems doubtful whether the heavy burden being borne by ships' staffs, dockyards and headquarters in the maintenance field will become very much lighter in the near future.

The Headquarters Problem

The effects of complexity are widespread. Obviously there is a need for increased staff at Headquarters to compete with the design task; for increased staff in the field to oversee the production of equipment; and for increased numbers of professional and technical officers in the dockyards to modify and repair it. A less obvious consequence is that with present methods the business of data retrieval from packs and files which are being added to at an astonishing rate has become so tedious and time-consuming that it has become to some extent a matter of chance. The amount of clerical and administrative business is increasing at the same rate; there are more letters to write, more contracts to place, more spare gear to provide. Expenditure on the preparation, not including printing, of handbooks and catalogues of spare parts has increased tenfold in three years, though this increase is partly due to the current attempt to catch up with the past. The Contract and Stores Departments, and the Admiralty Secretariat, are as deeply concerned as any; and P.D.A. has more bills to pay.

If experience in the United States Navy is any criterion, and in general their experience in the immediate past is a valid guide to what the Royal Navy may expect in the immediate future, this process is likely to continue. To give only one instance: a U.S. Navy Yard which is today performing the same task as it did ten years ago, then had 280 professional and technical officers and 14,000 industrials; and today has 3,000 professional and technical officers and 9,000 industrials, a ratio of one to three.

The conclusion that the Navy of 1968 will find it necessary to employ a considerably increased staff of professional, technical and administrative officers seems to be inescapable; and so does the secondary conclusion that unless the Navy's method of conducting its business can be radically revised, all will be totally submerged in paper. The trends outlined seem to resemble curves of natural increase, whose slope can only be altered by some cataclysmic disaster, or by the introduction of some new factor.

Automation

The application of modern techniques in administration is in its infancy, but there are today equipments and methods being developed which offer some hope for the future. They are coming into use in progressive firms which are in business to make money, and this seems to be some guarantee of their effectiveness; but it must be emphasized that no commercial organization is faced with problems one tenth as difficult as those that face the Navy. A simple example is Messrs. Moss Bros.; all their two and a half million credit accounts are recorded on microfilm and stowed in one small cabinet. This firm has discarded seven and a half tons of paper and can locate and print any account in thirty seconds. Microfilm selectors are now being developed which can search for drawings at the rate of five thousand frames a minute and print copies, *at the same speed*, of all drawings which are being sought.*

Information of all sorts can be stored on magnetic tape and used in computers, and both analogue and digital computers are in regular use for design purposes by D.M.E. Computer techniques are being applied to production planning using a development of the 'critical path' method. Suitable computers can receive design information on tape and actually deliver the output in the form of drawings; and developments in this and allied fields are proceeding apace. Documents and drawings can be viewed by television or transmitted in facsimile by co-axial cable or microwave.

Computers in Design

The principal virtue of computers in design is, however, not the direct saving of time and labour, though this is considerable; for instance, steam pipe stressing in the County Class was estimated to require 14,000 man-hours, and actually took 4,000 man-hours and two and a half days on a computer. The real gain is that it is possible to use entirely novel methods of design; for example, by employing a multi-anchor point system of pipe stressing in the latest version of the Y.100 machinery it has been found possible to reduce the amount of main and auxiliary steam piping by one third. Such a system would require a prohibitive amount of hand computation.

*'Improvement of Engineering Communications' by Harry J. Smith, *BuShips Journal*, May, 1963.

Operation and Maintenance of Machinery

The largest power station in the world, operated by the T.V.A., is entirely controlled by a computer; and if we continue with the development of equipment already at sea, such a machinery installation could be in the Fleet in a relatively short time. The need for such a development is of course open to argument because the degree of automation desirable in a warship designed to operate in a variety of roles throughout the world has not yet been determined.

Modern techniques are applicable to maintenance of machinery as well as its operation. In the near future most equipment drawings supplied to ships officers will be replaced by microfilms mounted in punched cards and used in conjunction with a reader-printer. These machines produce paper prints from microfilm, with a choice of magnification, in four seconds, and the print can of course be discarded when it has served its purpose. Modern punched card systems are extremely versatile, and a card can be classified and retrieved according to a number of different features: such a system would seem to have an application in maintenance planning.

Again in the near future, machinery will be equipped with monitors which will record all events and readings normally logged by hand, give warning of abnormal readings and print the information when ordered to do so: this printed output would replace the rough register. Such a device can be endowed with a memory of, say, twenty minutes, so that in case of a mishap to the machinery, it can be set to work to print out the events of the preceding twenty minutes; such a record would be of inestimable value to Boards of Inquiry and technical investigations.

Similar devices can be arranged to supply information on machinery wear and other matters of interest to the maintainer while the machinery is running, and it would be a simple step to feed this information into a computer whose output would be a printed maintenance plan for consideration by the ships officers.

Men in the Navy of the Future

Clearly the effect of technical advance on the ships' company of future ships will be a substantial increase in the number of senior technical ratings and a reduction in the number of junior ratings. It might be well at this point to consider whether any reduction in manual tasks can be expected in future; and it can be said that this is indeed the case. A machine with built-in devices for determining rotor position, wear down and so on, does not have to be stripped down to ascertain the facts. A boiler fired with distillate fuel does not require external cleaning. There is no particular reason, except poor design, why Diesel engines should leak oil in all directions. Given fine filtration there is no reason why bearings should not last indefinitely. Given clinically clean conditions in shipyards and factories, there is no reason why dirt should continue to be a problem; and it seems likely that the necessary measures would cost no more and might cost less than is at present paid for the repair of machinery damaged by dirt. There is no reason why bilges should continue to be a problem; and there is every reason to suppose that the traditional refitting pattern is unsuitable for highly complex modern surface warships, and that a continuing process of replacement of selected machines in accordance with a plan will take its place.

As the proportion of junior ratings declines, so will traditional patterns of training and advancement become less and less suitable. It seems probable that 'commissions' in the traditional sense will become outmoded and that an increased measure of specialization will become necessary because the difference between one class of ship and the next will become more and more marked; men will be less and less able to go from one ship to another and 'pick it up'.

The problem of technical education is a national problem; and it is apparent that the school leaving age was only raised just in time. Further progress is essential if the nation is to survive and it is to be hoped that the education of men entering the Services will keep pace with the needs. The Navy will have to take most determined steps to keep 'the greatest single factor' up to date throughout his career.

The effects on branch and rating structure are likely to involve a continuing process of evolution and change, and this is going to give rise to anomalies and difficulties in a Fleet which will, on the average, consist of ships ten years old and fifteen years out of date. The problems which face the professional departments and the headquarters organization have their counterpart in the problems which face the personnel departments and the officers and men in the Fleet.

Conclusion

The pace of technological change is such that little short of a revolution in the naval Service will match the requirements. This change is inevitable and must be recognized at every level and in every activity. The Navy is a microcosm of the nation, and so far as it is able, must seek to lead industry and other Government Departments to a similar recognition of the facts of life in the latter half of the twentieth century.