A DATA COLLECTION EXPERIMENT —EMPLOYMENT INFORMATION

BY

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Introduction

The data collection experiment in H.M.S. *London* (1) was brought to an end, as originally planned, at the end of March, 1968. It had then run from docking to refit, some eleven months. The analysis of the data collected is now in hand. Until that is done it will not be possible to assess finally the degree of success achieved. The aim of this article is to present some of the information already available and to show the kind of information generated from the employment data.

Ship Use

The way in which the ship is used clearly influences, not only the ease with which data is collected, but also the data itself. To provide a background against which the results can be viewed, FIG. 1 shows a summary of the ship's use on weekdays in terms of sea or harbour and such important activities as leave and Fleet Maintenance Unit support. The two and a half months in harbour at the beginning of the experiment were the latter part of the period spent alongside repairing the damage done by a galley fire.

Harbour Upkeep Opportunity

How does the opportunity for upkeep in harbour revealed by the programme in FIG. 1 compare with the average of such opportunity for the Fleet? A method has recently been devised of evaluating operational programmes to establish whether sufficient harbour upkeep opportunity has been included. The criterion is whether the programme allows enough harbour time on weekdays for the application to marine engineering upkeep of that quantity of skilled effort implied by the regulation allowance of Assisted Maintenance and Self Maintenance. The comparison is made in harbour skilled man-days; due allowance being made, when calculating the programmed quantity, for leave, jollies during foreign visits etc., as well as Fleet Maintenance Unit assistance. The results are plotted as the cumulative sum of the difference between the calculated figure and the allowance.

FIG. 2 shows such a plot for the programme of H.M.S. *London* during the period of the experiment. The horizontal datum is the regulation allowance expressed as a constant rate. Thus points above the datum represent a credit and those below a debit. An ideal programme would start at the end of an Assisted Maintenance Period on the datum, fall away from it, partially recover at the Self Maintenance Period, fall away again and finally recover to the datum at the next Assisted Maintenance Period.

If the credit were unlimited, ships could at times build up large credits which would invite over-use until the normal debit position was re-established. But there is a limit to the amount of credit which can be absorbed in this way. Since defects cannot be rectified before they occur material credit is logically limited to planned maintenance work which can be done ahead of time. This

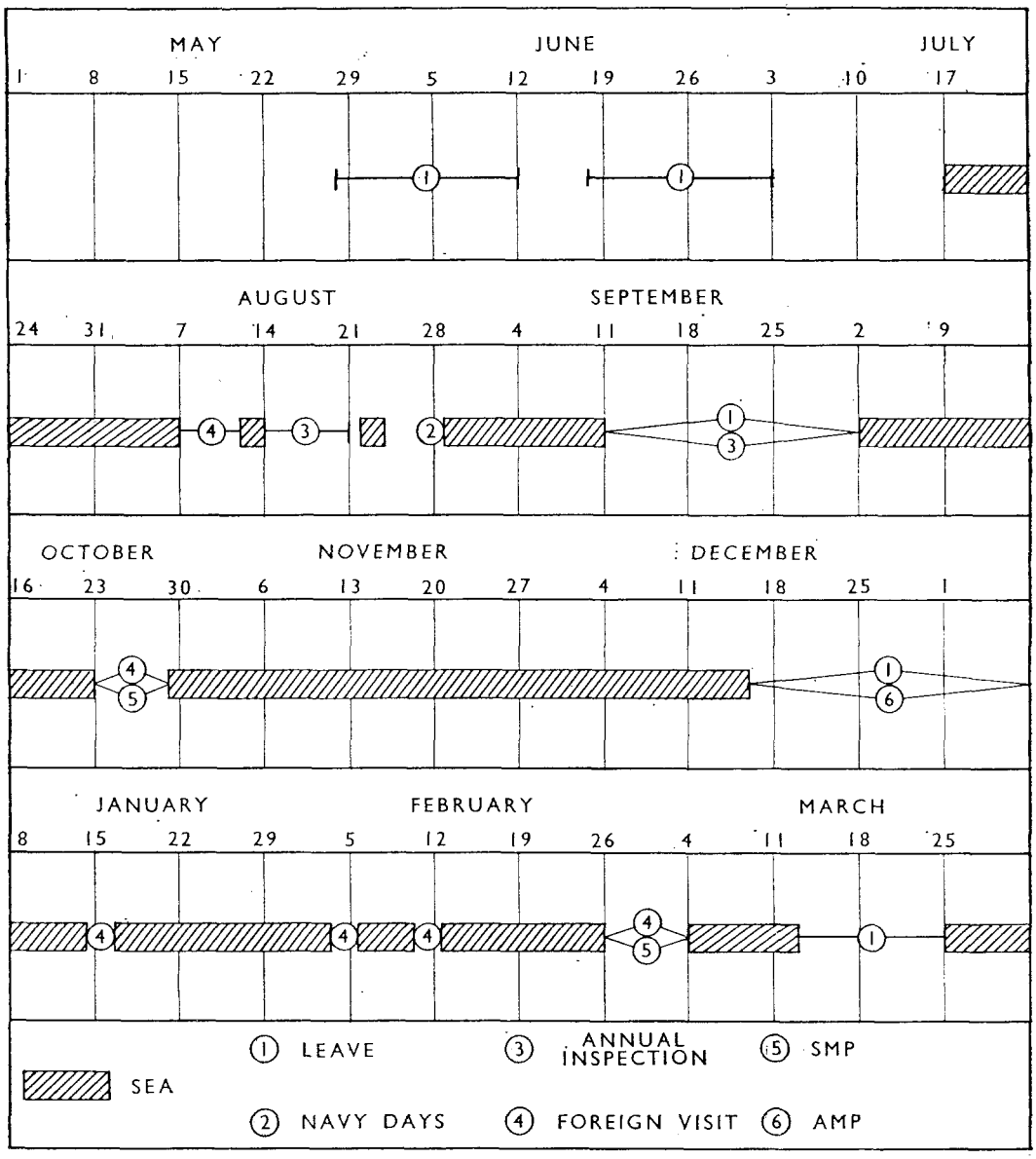

FIG. 1—SHIP PROGRAMME FACTORS AFFECTING UPKEEP

also is limited, for to do planned maintenance much too early makes nonsense of the ruling periodicities. Twenty-five per cent of the periodicity seems to be about as far as it would be reasonable to go in advancing planned maintenance. The equivalent in skilled harbour man-days is therefore the practical maximum of usable credit that can be built up. This value is used as a credit limit and explains the horizontal form of the graph for the early part of the period.

It would, perhaps, be prudent to stress that the former is a material argument. Credit in human terms will almost certainly continue to grow after the material limit is reached, because of the reduction in pressure. No doubt there is a limit there too!

To return to the original question, how did the ship's programme compare with par for the Fleet? It is a satisfactory programme from mid-July to the end of March; the outstanding debit at that time being about right for a ship beginning a refit. Satisfactory means in this context that the minimum opportunity was provided; but no more. This is par.

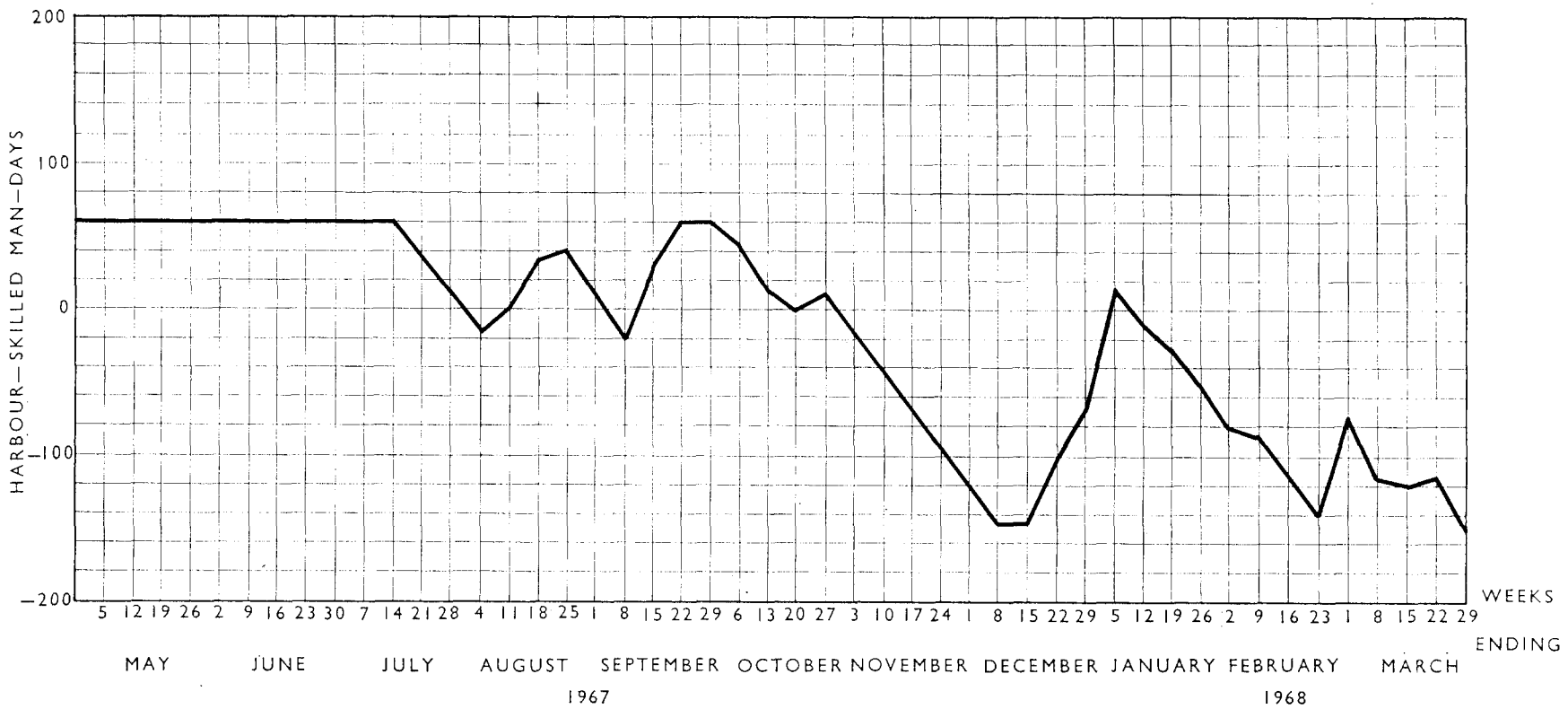

FIG. 2—CUMULATIVE HARBOUR UPKEEP OPPORTUNITY

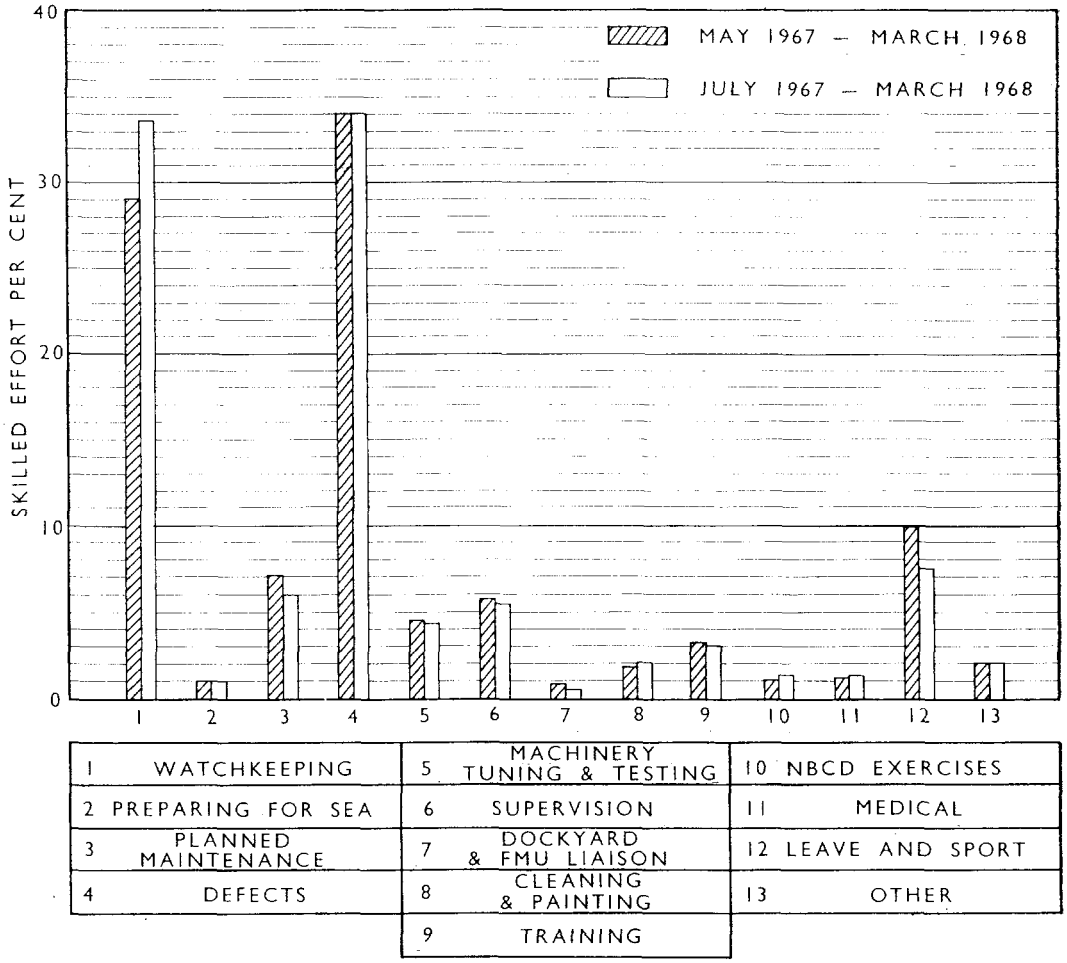

FIG. 3—DISTRIBUTION OF SKILLED EFFORT

Personnel Factors

A further factor which must have some bearing on the experimental results is a major personnel change in October. Both the Marine Engineer Officer and the first phase changed in that month. The latter entailed changing one third of the senior and junior rates resulting in the absorption of significant amounts of time in familiarization and training. The effect is impossible to isolate, but it probably contributed to the overtime level between October and Christmas.

Employment Data and Information

The body of data consists of a record, broken down into specified categories, described fully in (1), of the work done by each member of the Marine Engineering Department. Thus it lends itself to the study of the way in which the total effort available during the period was distributed between activities and working groups and how that distribution varies with time. It is not directly related to equipments or the incidence of individual defects; nor does it cover work done during the period by Fleet Maintenance Units. Where their employment figures are used they have been provided by the Fleet Maintenance Unit concerned.

The data were reduced as the experiment progressed, weekly and monthly category totals being produced for each section. In plotting results on a time base the category monthly totals have been expressed as average weekly totals to eliminate the distortion produced by a mixture of four and five-week

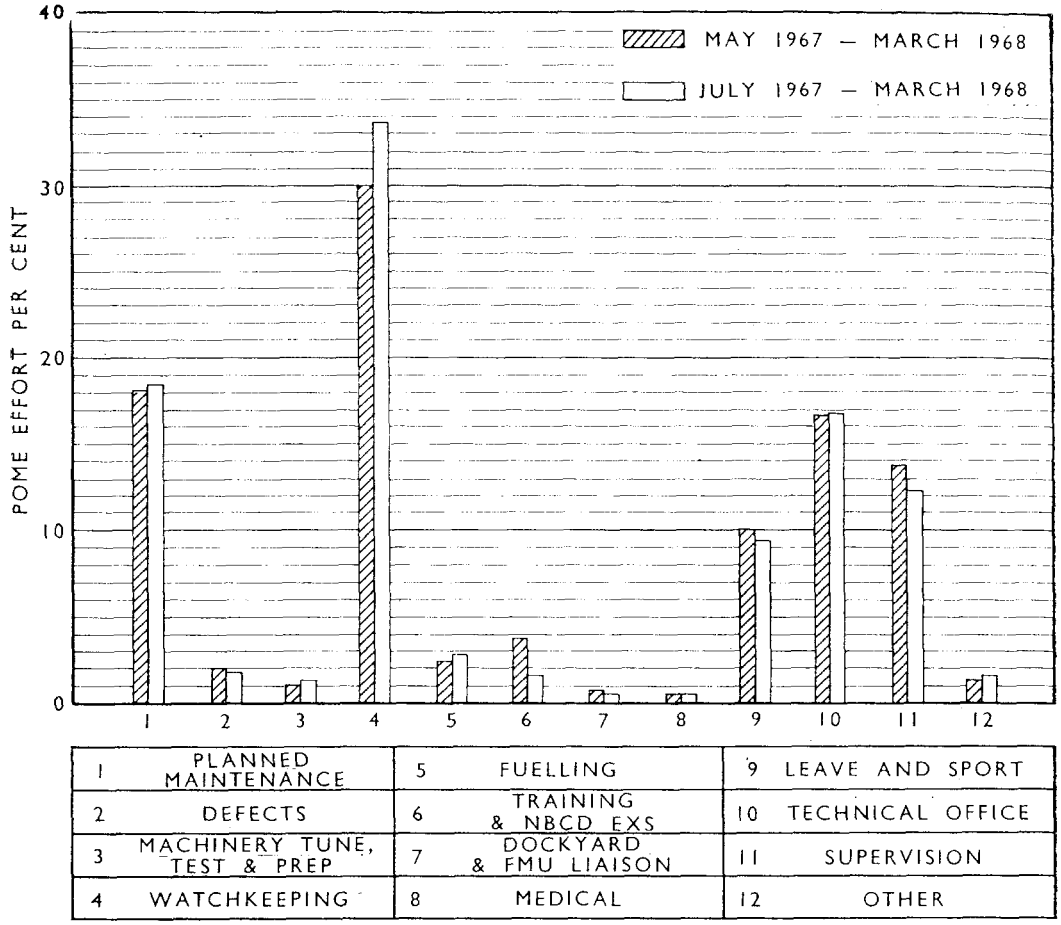

FIG. 4—DISTRIBUTION OF POM(E) EFFORT

months. Activity measures have been presented in absolute terms where they are plotted on a time base, but as a percentage when considering totals for the whole period. To use percentages for the former would have introduced distortion due to the considerable variation in monthly totals arising from the difference between sea and harbour working weeks and the sea/harbour mix in each month.

Effort Distribution by Category

FIG. 3 shows the breakdown of skilled effort for the whole period and the period July to March. The latter is included to show the magnitude of the distortion introduced by the two months, May and June, spent in harbour. All else is overshadowed by the amount of effort devoted to watchkeeping and defects; planned maintenance and leave and sport following a long way behind. The ratio between defects and planned maintenance is more than four to one, a feature which is examined in more detail below. Cleaning, painting and preservation hardly seems appropriate to a skilled effort breakdown, but this was the effort devoted to the final phase of preparation for annual inspection. It seems likely that a similar effect could be found in many other ships. But in this case it was measured and its significance is apparent.

FIG. 4 shows the distribution of POM(E) effort. In this case the distortion introduced by two months in harbour is almost confined to watchkeeping. This is also the main load. A substantial effort was devoted to planned maintenance, however, with technical office, supervision and leave and sport as the other important contributors.

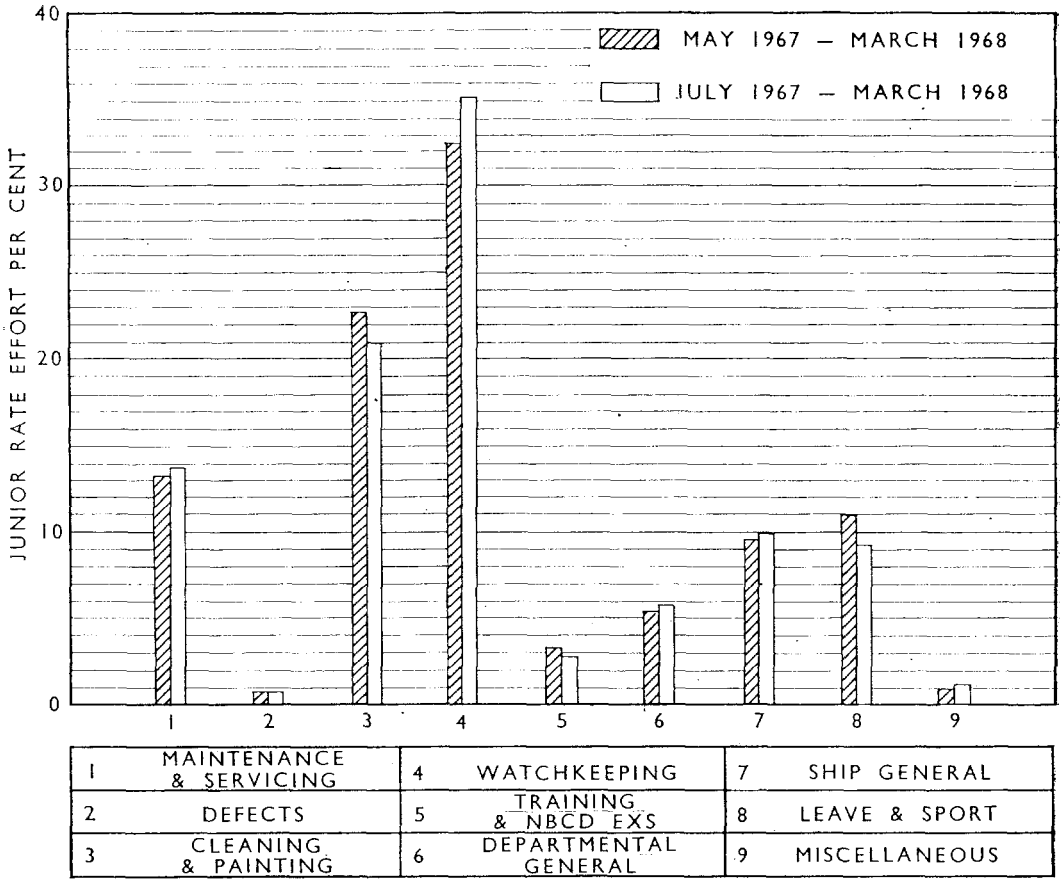

FIG. 5—DISTRIBUTION OF JUNIOR RATE EFFORT

FIG. 5 shows the distribution of Junior Rate effort. Again the distortion introduced by the harbour period is not great. Watchkeeping dominates again; cleaning and painting absorbs a large amount of effort and the contribution to equipment servicing, maintenance and defects is clearly important, though not perhaps as high as many will think desirable. General ship duties absorbed about as much effort as leave and sport and general departmental duties about half that.

Skilled Effort Distribution in Time

FIG. 6 shows the way in which the skilled effort was divided between major categories month by month. The category 'other' in this case includes preparing for sea, machinery tuning and testing, supervision, Dockyard and Fleet Maintenance Unit liaison, cleaning and painting, training, NBCD exercises, Medical and a small undefined quantity. These relatively minor categories have been assembled thus to avoid confusing the diagram with detail.

During the running period, July to March, the total upkeep quantity was reasonably constant, except for August when the breakdown was distorted by the annual inspection. The variation in the totals is a measure of operational stress as it is related to the amount of sea-time, discernable by the size of the watchkeeping component. An exchange of planned maintenance for defects relating roughly to the operational stress is apparent. The principal exceptions to this, September and December, coincide with the two Assisted Maintenance Periods, when the time in harbour at extended notice and Fleet Maintenance Unit assistance with defects, allowed a greater concentration on maintenance.

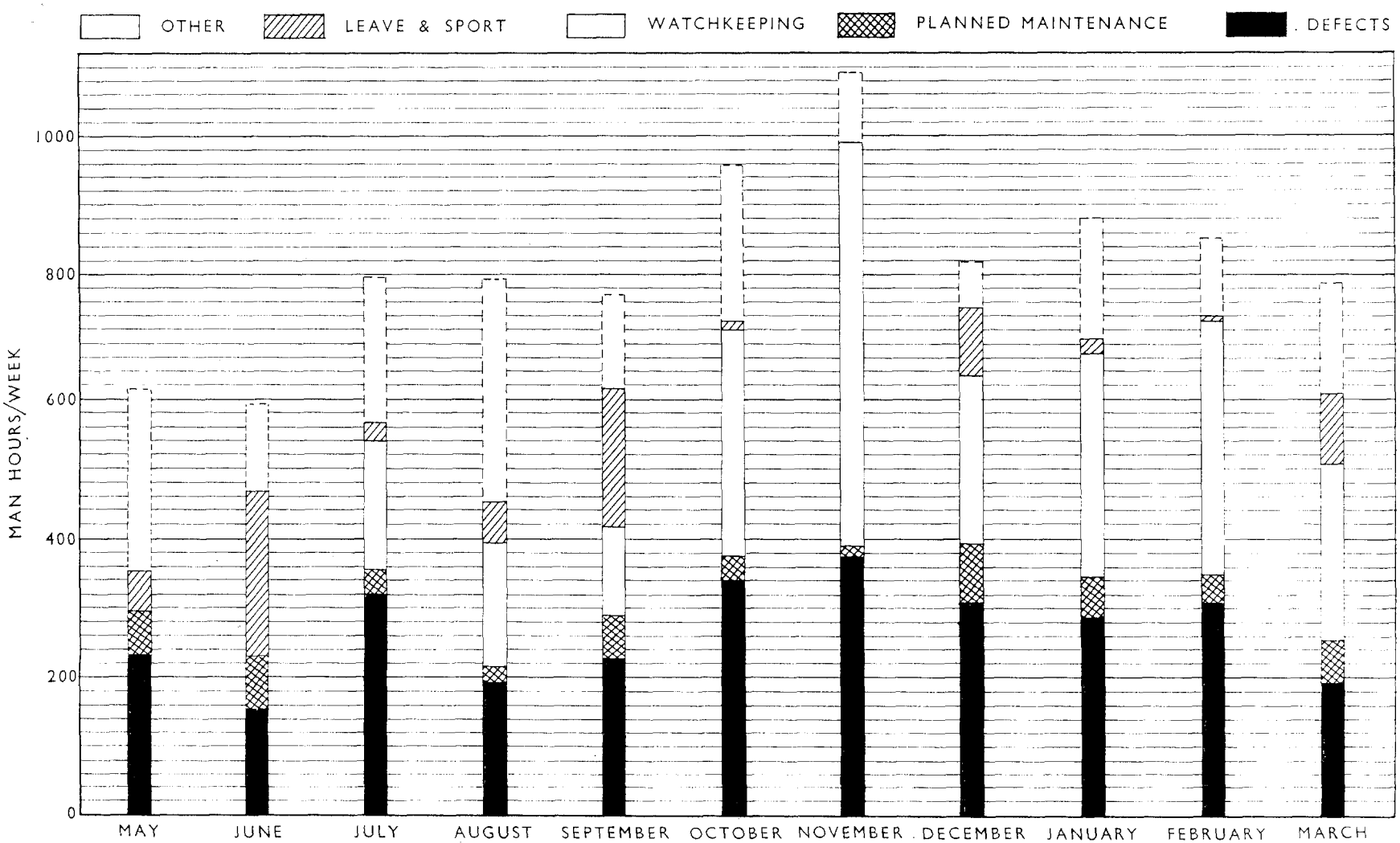

FIG. 6—SKILLED EFFORT BREAKDOWN BETWEEN MAJOR COMPONENTS

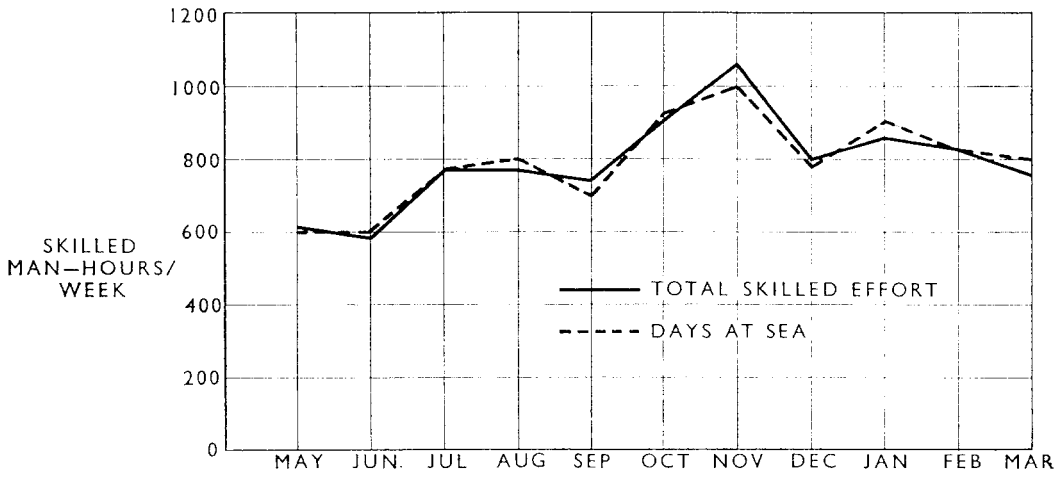

FIG. 7—CORRELATION BETWEEN TOTAL SKILLED EFFORT AND DAYS AT SEA

The watchkeeping element is a very important contribution. When added to the relatively constant upkeep effort it causes, in an imprecise way, the variation in the total effort. Watchkeeping and upkeep must match the demands arising from the operational programme and machinery derangement. While some spreading of the load in the latter, by deferring work, is frequently possible the former must be satisfied. Together they lead to overtime working during periods of moderate to high operational intensity.

Validity of Effort Totals

How valid are the data or, what is perhaps more important in this context, how valid are the category totals? Reference (1) explains in detail the mode of collection. In brief, the employment of the individual was recorded daily by a supervisor. He assembled the facts from verbal reports by the individual and from his own knowledge. He made the daily statement balance. The Midshipman checked the daily and weekly statements before producing the monthly totals. Thus, though errors could creep in, they are unlikely to be large. If the totals could be proved it would be reasonable to assume that the data is reliable at lower levels.

The category totals themselves are intuitively satisfactory and there is no reason to doubt them. When the total effort per month, or rather the mean weekly effort per month is examined, however, the variation from month to month seems surprisingly large. Some variation is to be expected as the sea working week is longer than the harbour working week and the watchkeepers' working week longer than either. Thus, if the monthly totals are correct, there should be a good correlation between the mean working week per month and the days at sea per month. Absolute precision cannot be expected for personnel bearing changes occur as well as temperate/tropical routine changes. Also the months used for one quantity differ somewhat in length from the months used for the other.

FIG. 7 shows the result of plotting mean skilled effort per week with days at sea per month expressed in the form:-

$$Te = aTs + b$$

where

Te = Equivalent effort in man-hours/week
Ts = Days at sea in the month
a = constant = 14·2
b = constant = 600.

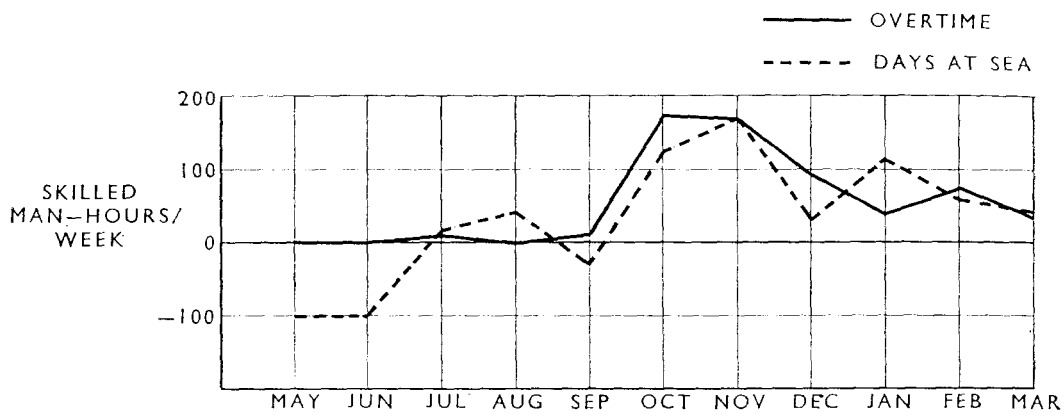

FIG. 8—CORRELATION BETWEEN SKILLED OVERTIME AND DAYS AT SEA

The correlation is reasonably good for skilled effort. Correlations of similar quality are also obtained for the POM(E) and Junior Rate efforts. On this evidence the effort and category totals are considered to be valid and it is deduced that similar quantities on a weekly and monthly base are also sufficiently valid for the establishment of reliable patterns and trends.

Overtime

Overtime in the ship environment is familiar to all as a concept. But as a quantity it is difficult to use for it is difficult to define in the first instance and the need for interpretations of increasing subtlety soon becomes apparent. However, the attempt was made because it promised to be a guide to any mismatch between task and resources. Overtime was defined as time spent in work at non-routine times. Thus work performed in the middle watch by a watchkeeper is not overtime, but it is if performed by a dayworker. Similarly defect work performed out of working hours by the duty watch is overtime, but their rounds or attendance at a fire party exercise is not.

The variation in overtime over the period of the experiment is shown in FIG. 8. The cause of the overtime is either the growth of the watchkeeping and upkeep load beyond the routine capacity of the staff or the incidence of urgent defects at inappropriate times. The total watchkeeping and upkeep load must vary with ship usage and the incidence of urgent defects is also likely to be related to usage. Thus overtime ought to correlate with intensity of ship use. If ships usage in terms of days at sea/month is expressed in the form:-

$$Te = aTs + b$$

where

Ts = Days at sea in the month

Te = Equivalent overtime/week for the month

a = constant = 9·75

b = constant = $-10a = -97{\cdot}5$

then a fair correlation is obtained. (see FIG. 8.) This is to say that overtime begins to be felt when the ship is used for more than ten days per month.

The value of the constant depends upon a number of factors, one of which is the amount of redundancy built into the machinery. Greater redundancy means less urgency in rectifying a defect and therefore a smaller likelihood that a given defect will cause overtime. With minimal redundancy overtime

would be expected to begin at a very low value of b as the arguments presented by Barrett (2) make clear. It is a considerable tribute to the redundancy provided in the County Class machinery that the value of b is so high.

The value of b also depends upon the adequacy of the complement. Indeed FIG. 8 suggests that the complement was more than adequate for May and June because the equivalent overtime becomes negative in those months. In fact this must be so in a harbour period if no backlog of work exists. It does not mean, however, that the complement could be reduced, for this margin provides for leave and recreation as well as activities like specialist training.

Defect Effort Distribution

A natural consequence of the COSAG propulsion plant in the County Class destroyer is that the Marine Engineering Department can be sub-divided for management purposes into three sections based upon the steam propulsion plant, the gas turbine propulsion plant and the outside machinery. This was the case in H.M.S. *London*. It is therefore possible to examine the relative capacities of these sections to absorb defect effort; of particular interest where the comparison between steam and gas turbine propulsion plants is concerned.

The understanding of the significance of the distribution of defect effort calls for an appreciation of the machinery content of each section and the usual methods of operating the plant as a whole. The machinery content of each section is listed in TABLE 1.

Normal machinery operation is a matter of using one of two modes: either as a steam ship with a gas turbine alternator running for emergency use; or as a gas turbine propulsion ship with one boiler auxiliary and a gas turbine alternator running for emergency use. These modes are determined by the limited gas turbine alternator power available and the time required to get the steam plant underway from cold. The resulting usage of the gas turbine plant was low, about 5 per cent of that of the steam propulsion plant. The gas turbine alternators, on the other hand, accumulated a large number of running hours, totalling for three of them 50 per cent of the running hours achieved by the two steam alternators.

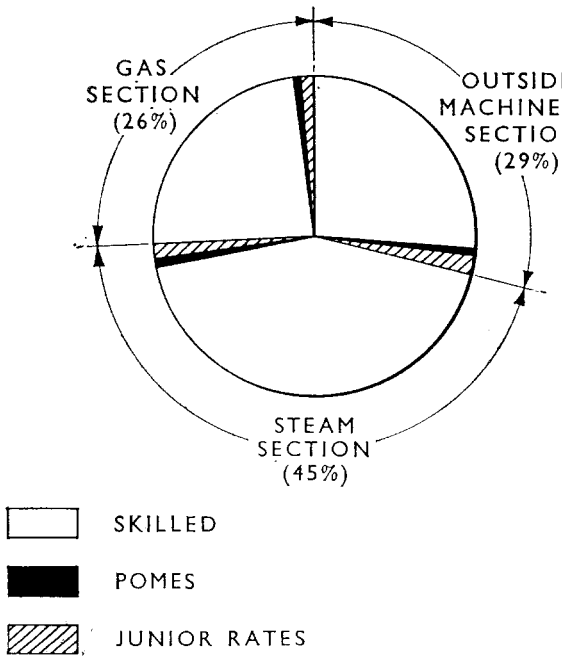

FIG. 9—DISTRIBUTION OF DEFECT EFFORT BY SECTIONS

The distribution of the defect effort between the three sections is shown in FIG. 9: the proportion for steam, gas and outside machinery being roughly 2:1:1. As TABLE I shows, there is more to the gas turbine section than gas turbines. Unfortunately the employment data, being man and group orientate drather than equipment orientated, offers no means of discovering how the effort was distributed within the section. This must wait for the completion of the analysis of the equipment data. However, a preliminary survey of equipment defect data suggests that about one third of the gas turbine section defect effort is attributable to the propulsion gas turbines and gas turbine alternators. This does not include ancillaries or any part of the transmission.

TABLE I—*Section Machinery Responsibilities*

Steam End		*Gas End*		*Outside Machinery*
Main Boilers	2	G6 Gas Turbines	4	Steering Gear
Forced Draught Blowers	2	G6 Lub Oil Pumps	2	Stabilizers
Compound Turbine Sets	2	G6 Lub Oil Filters	2	Capstans
Condensers	2	G6 Dieso Boost Pumps	2	Air Conditioning Plant
Main Air Ejectors	2	Main Gearing	2 sets	Refrigerating Plant
Turbo Driven Extraction Pumps	2	Main Centrifugal L.O. Pumps	2	Galley Machinery
Motor Driven Extraction Pumps	2	Standby L.O. Pumps	2	Laundry Machinery
Harbour Service Fuel Pump	1	Lub Oil Coolers	4	General Service Hydraulic Systems and Equipments
Deaerators	2	Lub Oil Filters	10	L.P. Air System
Deaerator Extraction Pumps	2	Gearing Lub Oil System	2	Syrens
Main Feed Pumps	3	Propellers	2	Domestic Steam Systems
FFO Pumps	3	Shafting and Fittings	2 sets	Chilled Water System
FFO Heaters	3	Allens 450 kW GTAs	2	Boat Engines
Pilot Burner Pumps	2	Ruston 750 kW GTA	1	
Main Circulators	2	HP Air Compressors	2	
Auxiliary Circulators	1	HP Air System up to HP/LP Reducers	1	
Servo Air Compressors	3	Diesel Air Compressor	1	
1000 kW Condensing TAs	2	Auxiliary Circulating Pumps	3	
Distilling Plant (Compound)	2	Lub Oil Separators	3	
Steam and Drain Systems		Dieso Transfer Pump	1	
FFO and Dieso Systems		Auxiliary Boilers	2	
Feed System				
Lub Oil System				
Gland Evacuation System				
Servo Air System				

TABLE II—*Defect Maintenance Ratio—Total Task*

	June '67–Jan. '68		June–Sept.		Oct.–Jan.	
	Defects	*Maint.*	*Defects*	*Maint.*	*Defects*	*Maint.*
Ships Staff Skilled	9,471	1,865	3,954	943	5,517	922
Ships Staff Other	268	12,411	174	4,786	94	7,625
FMU Skilled	733	440	108	339	625	101
FMU Other	375	307	111	117	264	190
Outstanding at End	707	263	280	50	707	263
Total	11,554	15,286	4,627	6,235	7,207	9,101
Outstanding at Start (Subtract)	140	162	140	162	280	25
Total	11,414	15,124	4,487	6,073	6,927	9,076
Ratio Defect/Maint.	0·755		0·738		0·763	

The Defect/Maintenance Ratio

The defect/maintenance ratio is a simple concept: the ratio between defect effort and maintenance effort. Several definitions of defect and maintenance efforts are possible, however, and confusion easily enters. Is effort task or achievement; is maintenance simply skilled maintenance or does it include POM(E) or Junior Rate effort applied either directly or, in support, as a mate; and does Junior Rate maintenance include servicing? It is here discussed in two forms: the ratio of total equipment upkeep tasks including servicing; and the ratio of skilled equipment upkeep tasks.

The total task ratio is given by:

$$\frac{\begin{array}{c}\text{Defect Task}\\ \text{equals}\\ \text{Ships Staff Skilled Achievement}\\ \text{plus}\\ \text{Ships Staff Other Achievement}\\ \text{plus}\\ \text{FMU Skilled Achievement}\\ \text{plus}\\ \text{FMU Other Achievement}\\ \text{plus}\\ \text{Outstanding Task at End}\\ \text{minus}\\ \text{Outstanding Task at Start}\end{array}}{\begin{array}{c}\text{Maintenance and Servicing Task}\\ \text{equals}\\ \text{Ships Staff Skilled Achievement}\\ \text{plus}\\ \text{Ships Staff Other Achievement}\\ \text{plus}\\ \text{FMU Skilled Achievement}\\ \text{plus}\\ \text{FMU Other Achievement}\\ \text{plus}\\ \text{Outstanding Task at End}\\ \text{minus}\\ \text{Outstanding Task at Start}\end{array}}$$

The quantity which converts achievement to task is, for defects, the difference between the outstanding task at the end and that at the beginning of the appropriate period; that at the beginning being the outstanding task at the end of the previous period. But for the maintenance task the outstanding task at the end of one period is unlikely to be equal to the task carried forward into the beginning of the next period. The four-monthly items at least will be omitted. Based on the proportion of four-monthly items in the outstanding work at the end of May, the last time details such as this were reported, it has been assumed that half the outstanding maintenance at the end of one third is carried forward to the next.

TABLE III—*Components of Maintenance and Servicing Achievement*

	Maintenance and Servicing	*Mate for Maintenance and Servicing*
Ships Staff Skilled	1,866	—
Ships Staff POM(E)s	1,772	—
Ships Staff Junior Rates	7,989	2,650
FMU Skilled	440	—
FMU Other	307	—

The outstanding task at the beginning and the end of the experimental period is not known with any accuracy, but it is known for the ends of the thirds June/September and October/January. At the end of January, however, the backlog was divided into two parts, those defects which would be progressed normally and those which would be deferred until refit. Many of the latter had been found as a result of the careful checking by the ships staff and Western Fleet staff in the Defect List preparation. Had not a refit been approaching a number of those deferred items would no doubt have come to light and been regarded as part of the normal backlog at this time. To put a value on the proportion of items which would have been affected in this way is difficult, but it seems likely that one third is about right. That proportion has therefore been included in the outstanding task and the remainder omitted.

TABLE II shows the derivation of the Total Task Ratios. They are remarkably similar for the two thirds considered, despite a marked difference in the operating intensity. The explanation seems to be that a substantial increase in skilled defect work was largely offset by growth in other maintenance work. This was probably due to more servicing being required in the third having the higher usage than in that in which a larger proportion of time was spent in harbour with equipment out of use.

The large size of the 'ships staff—other' contribution is worth examination. This contains effort spent on servicing as well as on maintenance. The magnitude of the servicing commonent is clearly of interest. Unhappily no attempt was made to distinguish between servicing and maintenance in devising the recording system. Indeed it would have been difficult, though probably not impossible, to have done so. Hence no measurement of this quantity is available, though with suitable assumptions it is possible to estimate the proportion of the total maintenance effort devoted to servicing. Lacking a measure of outstanding servicing from which to construct the servicing task this has to be a comparison of maintenance and servicing achievement. The relevant category totals for the period June to January are shown in TABLE III.

The ships staff and Fleet Maintenance Unit skilled quantities may readily be categorized as maintenance. Since the Fleet Maintenance Unit does not undertake servicing the 'FMU other' quantity must also be maintenance. Servicing is almost invariably an activity performed by one man, usually a Junior Rate. It is therefore unlikely that any significant part of the Junior Rates mate quantity was devoted to servicing. Hence that too is maintenance. On the other hand maintenance and servicing carried out by Junior Rates alone is almost certainly servicing. The POM(E)s, however, became involved in both, and their maintenance and servicing achievement must be split between the two activities. It is estimated that about three quarters of that quantity will have been devoted to servicing. On this basis 62 per cent of the maintenance and servicing achievement was devoted to servicing. This may seem a high proportion, but it is well to remember that a 5-minute daily servicing item is the equivalent of a 20 man-hour 8-monthly routine and even a 10-minute weekly item corresponds to a $5\frac{1}{2}$ man-hour 8-monthly one.

In the light of the discussion in recent years of the possibility of transferring manpower from ship to shore support, the Fleet Maintenance Unit contribution to Defect and Maintenance effort is surprisingly small. This is partly due, of course, to current limitations of shore support and to the existence of a substantial body of effort in the ship. But in the main it is due to not being able to wait long enough to get to a Fleet Maintenance Unit. At least this is true for defect work. Similarly opportunity maintenance work coupled with defect work cannot wait. It is also often convenient to use maintenance items for fillers when the defect back log is low, or not pressing, and time is too short to tackle major defect items. It is mainly for these reasons that the complete exchange between defect and maintenance effort implied by Barrett (2) and Peaver (3) did not take place. Indeed at the time of maximum stress, when overtime was running at 20 per cent, 20 man-hours/week were still being devoted to maintenance.

A major factor in assessing a ship's capacity to transfer work ashore is opportunity to do so. As FIG. 1 shows, the ship's programme would have provided little opportunity outside scheduled Assisted Maintenance Periods or Self Maintenance Periods for such a transfer. The provision of additional opportunity must depend upon need and is thus governed by the amount of work it is possible to undertake at sea, or, more correctly, the amount which it is not possible to undertake at sea. The maintenance opportunity assessment of FIG. 2 offers a means of assessing what proportion of the upkeep achievement was in fact accomplished at sea. To avoid any distortion which might be introduced by the period alongside in May/July, the period chosen for this assessment is August–March. Making the assumption that the short day resulting from working tropical routine in the Assisted Maintenance Period in December/January is offset by overtime worked in harbour on other occasions, the skilled harbour upkeep effort is given by the harbour skilled effort allowed minus the shortfall in supply plus the skilled work done on Saturdays and Sundays at routine times minus the skilled effort devoted to non-upkeep activity in harbour. This quantity is 41 per cent of the skilled effort recorded, 9 per cent being contributed by Fleet Maintenance Units. The remainder, 59 per cent, is the skilled upkeep work done at sea.

Though the Fleet Maintenance Unit contribution is small it would be a grave error to underestimate its importance. There are both defects and planned maintenance which cannot be undertaken without extended notice for steam. The length of the resulting harbour period is governed to some extent by the available effort. The Fleet Maintenance Unit thus assists in reducing ship downtime for this purpose. Also, its contribution is, after all, the balancing item and as such probably makes the difference between success and failure. It is this which makes it possible for ship's company skilled ratings to take leave and that is essential if the subsequent periods of stress are to be tolerated.

The skilled defect/maintenance task ratio is given by:-

$$\frac{\text{Defect Task}}{\text{Maintenance Task}}$$

Defect Task = Ships Staff Skilled Achievement + FMU Skilled Achievement + Outstanding Task at End − Outstanding Task at Start

Maintenance Task = Ships Skilled Achievement + FMU Skilled Achievement + Outstanding Task at End − Outstanding Task at Start

For the thirds June–Sept. and Oct.–Jan. the ratio was 3·6 and 5·2 respectively with a value of 4·5 for the whole eight months. The derivation of these figures is shown in TABLE IV.

TABLE IV—*Defect/Maintenance Ratio—Skilled Task*

	June '67–Jan. '68		June–Sept.		Oct.–Jan.	
	Defects	*Maint.*	*Defects*	*Maint.*	*Defects*	*Maint.*
Ships Staff Skilled	9,471	1,865	3,954	943	5,517	922
FMU Skilled	733	440	108	339	625	101
Outstanding at End	707	263	280	50	707	263
Total	10,911	2,568	4,342	1,332	6,849	1,286
– Outstanding at Start	140	162	140	162	280	25
Total	10,771	2,406	4,202	1,170	6,569	1,261
Ratio Defect/Maintenance	4·5		3·6		5·2	

The result suggests that during the periods of average operating intensity a skilled ratio of about 4·5 : 1 is to be expected though in periods of higher usage this value will increase.

It is tempting to calculate the Defect/Maintenance ratios for the individual sections for this might throw some light on the relative upkeep merits of steam, gas and ship service machinery. But this sub-division will have to wait for the equipment information, for it is not possible to break down the outstanding defect and maintenance task into sections. The potential error introduced by neglecting the outstanding task is so large as to make the ratios valueless.

The Engineering Mechanic Contribution to Upkeep

The extent of the Engineering Mechanic's contribution to upkeep, what it is and what it should be, has been the subject of considerable discussion over many years. The pressure has all been toward his greater involvement in this activity, whether he be M(E)II or Chief M(E). At the same time, however, modern ship design with its automatic controls has led to a reduction in the Engineering Mechanic proportion of the Marine Engineering Department and indeed there seems to be a downward trend in numbers relative to the complexity of the machinery and cleaning task. The conflicting demands of mechanical upkeep, cleaning and preservation, watchkeeping and training are in modern ships felt perhaps more acutely than ever before.

FIG. 10 shows the man-hours devoted by M(E)s to their main activities. The balancing item 'other' is included to cover a number of minor activities which, individually, are not of great significance. The complete set of graphs is shown to demonstrate that an increase in equipment upkeep can only come from a reduction in cleaning and painting. The category cleaning and painting, incidentally, covers all forms of structural preservation as well as brightwork.

There is clearly no room for a reduction in training. Indeed this looks very small already. It covers only time devoted to some kind of specific instruction, that devoted to double-banked watchkeeping being shown as watchkeeping. This amount of instruction was, in fact just sufficient to satisfy the advancement aims laid down in the last DCI on the subject, but it could not be reduced without a corresponding reduction in effectiveness. Indeed it is possible that some increase would be worth while particularly in improving the quality of the training provided for an M(E)II.

Extra-departmental activity covers the communal party, among other things such as helicopter fire party and storing, and this too admits of no cut. The

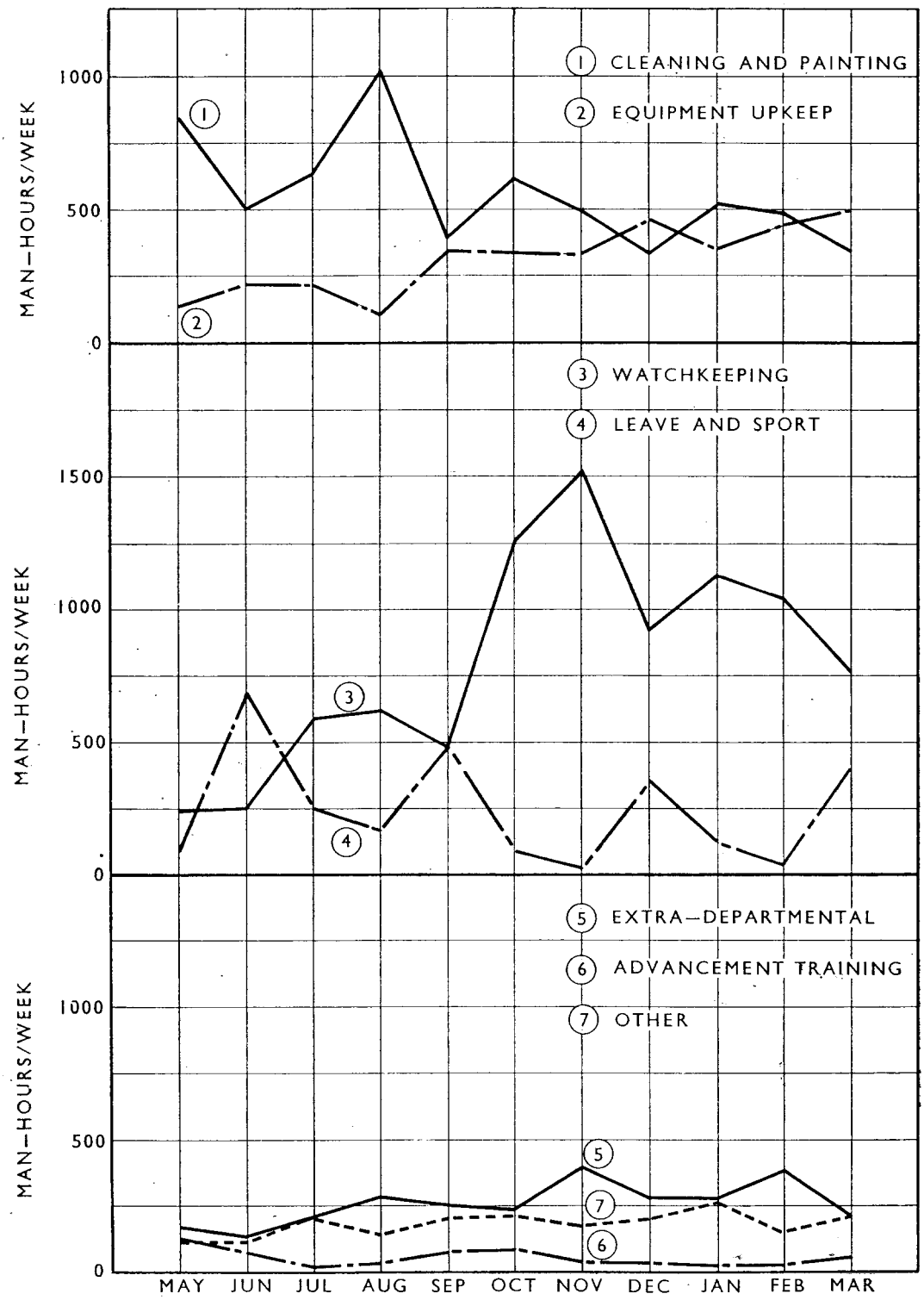

FIG. 10—JUNIOR RATE EFFORT DEVOTED TO SELECTED ACTIVITIES

two main peaks here are associated with periods of higher usage; times when demands for helicopter fire party and storing are particularly heavy.

Watchkeeping and leave and sport are complementary in shape though not in magnitude. The reason for the relationship of shape is only too obvious: the difference in magnitude is largely attributable to the difference between the length of the harbour working week and the watch-keeping week. Neither

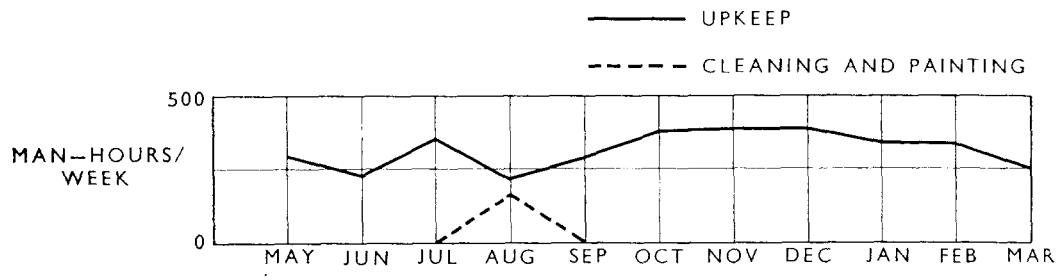

FIG. 11—SKILLED EFFORT DEVOTED TO UPKEEP AND CLEANING AND PAINTING

of these activities can be cut, certainly not watchkeeping, and leave only if in-commission G.S.C. leave is strictly limited to the minimum of two thirds of the allowance; not a practical proposition for a ship working from the United Kingdom.

Cleaning and painting and equipment upkeep are also complementary in shape and largely so in magnitude. There was, but for a drop in August, a steady increase in the amount of effort devoted to equipment upkeep. The reason for the increase was a constant endeavour to achieve it coupled, from October on, with a need to do so in order to reduce the overtime working of the skilled ratings. The increase was matched by a decline in the amount of effort spent on cleaning and painting. When the peak of May, due to a large amount of activity in bilges, and that of August due to the Annual Inspection, are subtracted, the downward trend is steady rather than dramatic. But something like 600 man-hours/week are really required to maintain a satisfactory state of cleanliness and preservation in the department, excluding the machinery space bilges. The price of the increased upkeep activity was apparent in a decline in the general standard of cleanliness and preservation.

The Annual Inspection

The harbour inspection took place in August, hence the peak in cleaning and painting. As might be expected there is a corresponding reduction in upkeep effort. FIG. 11 shows upkeep and cleaning and painting for skilled ratings where a similar exchange is apparent; unusual perhaps, but it was a case of every man to the pumps. The effort does not show in the POM(E)s plot because cleaning and painting disappears under the heading supervision, but since a change had taken place in the kind of work supervised a similar transfer had taken place. In retrospect the impact of inspection preparation on upkeep is frightening, but there is no doubt that the corresponding increase in effort on cleaning and painting was unavoidable if a satisfactory inspection standard was to be achieved.

Conclusions

In drawing conclusions from this information it is important to remember that it is based entirely upon evidence collected from one ship over a period of eleven months. Thus it can only describe historical occurrences in one ship. Inferences about County Class destroyers or ships in general must be drawn with care and with proper regard for the source and meaning of the information. That said, a summary of the results is given below together with certain conclusions about the employment information and three tentative conclusions of more general application.

(*a*) But for the period alongside from May to July, which had only a minor effect upon the results and none upon their validity, the experimental period was representative of Fleet operation. Just adequate harbour upkeep opportunity was provided.

(*b*) The main activities were, perhaps predictably: skilled—watchkeeping and defects; POM(E)s—watchkeeping, maintenance, technical office and supervision; junior rates—watchkeeping, cleaning and painting, and maintenance and servicing.

(*c*) Effort and category totals for the whole period are valid and those for months and weeks sufficiently so for the establishment of reliable patterns and trends.

(*d*) Overtime was related to ship usage; it becomes significant at usages above 10 days/month.

(*e*) Skilled defect effort was distributed between the steam, gas turbine and outside machinery sections in the proportions 45 per cent, 26 per cent, and 29 per cent respectively.

(*f*) 62 per cent of the maintenance and servicing achievement was devoted to servicing.

(*g*) Skilled upkeep work was divided into 59 per cent by ships staff at sea; 32 per cent by ships staff and 9 per cent by Fleet Maintenance Units in harbour.

(*h*) The skilled defect/maintenance ratio was 4·5 over 8 months. It is likely to be between 4 and 5·5 for a County Class destroyer depending on operational intensity.

(*i*) Some 600 man-hours per week are required to maintain a satisfactory level of cleanliness. Achieving this in a County Class destroyer is likely to limit the equipment upkeep contribution to about half that.

(*j*) Preparations for the Annual Inspection caused a substantial reduction in equipment upkeep during that month. This effect may well be found in many ships of the Fleet.

Acknowledgements

The author would like to acknowledge the continuous interest and steady application shown by the personnel of the Marine Engineering Department of H.M.S. *London* in collecting the data; in particular the work devoted to the reduction and analysis of the data, which forms the basis of this article, by Midshipman I. K. Jones, Chief Engine Room Artificer, G. A. Cartwright and Chief Engineering Mechanic, P. T. Fowler, was invaluable.

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