WORK STUDY—ONE WAY OF DOING IT!

BY

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The introduction of the General Service commission, because of its reduced length, will make availability of ships an even more important factor than before, for such short commissions will have the minimum time to produce a trained fighting unit, and any period spent repairing defects or carrying out maintenance will seriously curtail training time.

Dockyard refits, under present arrangements, may absorb three to four months or more of the eighteen month commission, and all other repair and maintenance work will have to be carried out under a set notice for steam. This has always been so, but in the future it may prove more restrictive than in the past, for the curtailed time to train the weapon users, may also curtail the time to effect repairs and maintenance.

Time is a factor which is rarely applied to work in the Service and, in particular, is little used in the Engineering Department. For example, how many ships assess any job in man-hours ? Due regard is paid to elapsed time for jobs, but all too often naval engineers, under restricted notice, take on work with grave doubts as to their ability to finish within the stipulated time. Why do these doubts exist ? Because little is known of just how long it takes to do any particular job and all too often there is a signal for dockyard or repair ship assistance, because of these doubts.

The principles of work study or job planning, can be applied to almost any job in the Service, and their application is not difficult in practice. The results once obtained can be left in simple diagrammatic form for all who may have to do the job afterwards, and may thus save succeeding commissions learning the hard way. Above all, the minimum of planning for any job will reduce the time required to complete that job. For example, the simple precaution of making sure that the tools required are being available *before* the job is started will save many man-hours, often spent in obtaining tools as they become necessary. In an emergency class destroyer, it may well be that someone has to fetch a $\frac{3}{4}$ in tap, which involves a climb of sixteen feet to the upper deck from the engine room, a twenty-seven yard walk forrard, then down ten feet to the workshop to obtain the key, open up the stowage, draw the tool and return. Meanwhile, nothing happens on the job. This may mean a half-hour delay, but when measured in man-hours is far longer. In a large ship, this delay is proportionately greater. A little forethought can save much time wasted in this manner.

PRINCIPLES OF WORK STUDY

The principles which offer such a worthwhile saving of time can be summed up as :—

Reducing to a minimum *before* work is started :

(*a*) What work shall be done
(*b*) How the work shall be done
(*c*) Where the work shall be done
(*d*) When the work shall be done.

In short—indicating each step, so that routine arrangements suffice to cause it to happen in the right place at the right time.

Work Study—Planning

One approach to planning work is :—

(1) *Preliminary.* Study drawings, and previous experience of the job. Break down work into separate group operations, and then make estimates (with full allowances for awkward nuts, etc.) of the time required, the type of labour needed, and amount of labour that can be employed.

(2) *Analysis.* Carry out job, and tabulate times taken, tools required, materials used. Analysis of these tabulated results will show where more labour, more time, and more skill is required. It will also show where these factors have been over-estimated. If the job is of a repetitive nature, average times, etc., may be taken.

(3) *Synthesis.* From the analysis, assess improved methods, rearrange order of work where possible, and produce an improved method for a reduced elapsed time. Diagram and note these operations and put them into practice as occasion arises.

(4) *Method.* From the synthetic diagram for the job, which is a trial and error result (or can be based on conjecture) a method of doing the job can be outlined. This should include detailed instructions, preferably in a job card and diagram form, covering :—

(*a*) Tools required
(*b*) Materials required
(*c*) Sequence of operations
(*d*) Grade of labour required
(*e*) Time for each operation
(*f*) Inspection required
(*g*) Final tests required.

(5) *Application.* Give explanatory talks to all engaged on the job. Explain how final method is evolved and its advantages. Introduce it as a means of reducing labour and time (in hot places, in engine rooms, etc.). Explain to each rating his part of the job in relation to the whole. Issue job cards for study and challenge team to beat the times set, and, whenever possible, set two or more teams on identical jobs to encourage competition. Upgrade engineer mechanics' skill whenever possible on jobs to increase their interest and pride of accomplishment, and to conserve skilled labour.

(6) *Integration of Effort.*

(*a*) Relate all work undertaken according to priorities affecting notice for steam.
(*b*) Pick teams for big jobs according to harmonious personalities.

(*c*) Stagger supervision times of C.E.R.A.s and E.R.A.s so that they can cover many jobs in working time.

(*d*) Arrange a full programme of work for every hand, for every hour of the day.

(*e*) Ensure that tools in limited supply are not overloaded.

(*f*) Stagger peak loads on men, tools, and materials.

The above outlines of the method of attack may be illustrated by the following example.

DISTILLER PUMP REPLACEMENT—H.M.S. 'CONSORT'

Carried out at Small Ships Maintenance Base, Kowloon, 18th to 19th February, 1955.

Preliminary—Outlines of the Job

(*a*) Ship reported distiller pump beyond repair and renewal was authorized.

(*b*) Small Ships Maintenance Base, directed to undertake job.

(*c*) New pump drawn a.m. from S.P.D.C., Hong Kong (turbine securing bolt-holes and stay bolt-holes in pump feet were not drilled, glands were unpacked).

(*d*) *Consort* arrived Small Ships Maintenance Base, at 1300, 18th February, 1955, under own power.

(*e*) Job inspected and signal made 'E.T.C. repairs 1600 19th February'.

Analysis—Sequence of Operations

(*a*) 1400 : work commenced.

(*b*) 1630 : turbine end free and some distiller pipes broken.

(*c*) 1830 : turbine in workshop (via improvised lifts by slinging in ship, torpedo davit into motorboat, then 200 yards by trolley to workshop).

(*d*) Turbine aligned to new pump in workshop, and holes drilled and tapped as required. Reassembled and checked for alignment.

(*e*) Turbine removed and distiller pump feet stay bolts drilled : workshop work completed 0200, 19th February.

(*f*) Old distiller pump removed to workshop by 2130.

(*g*) Turbine returned to ship by 0200, 19th February.

(*h*) Pump returned to ship by 0400, 19th February.

(*i*) Pump and turbine bolted down and aligned by 0600.

(*j*) All pipes, etc., replaced and connected by 1600.

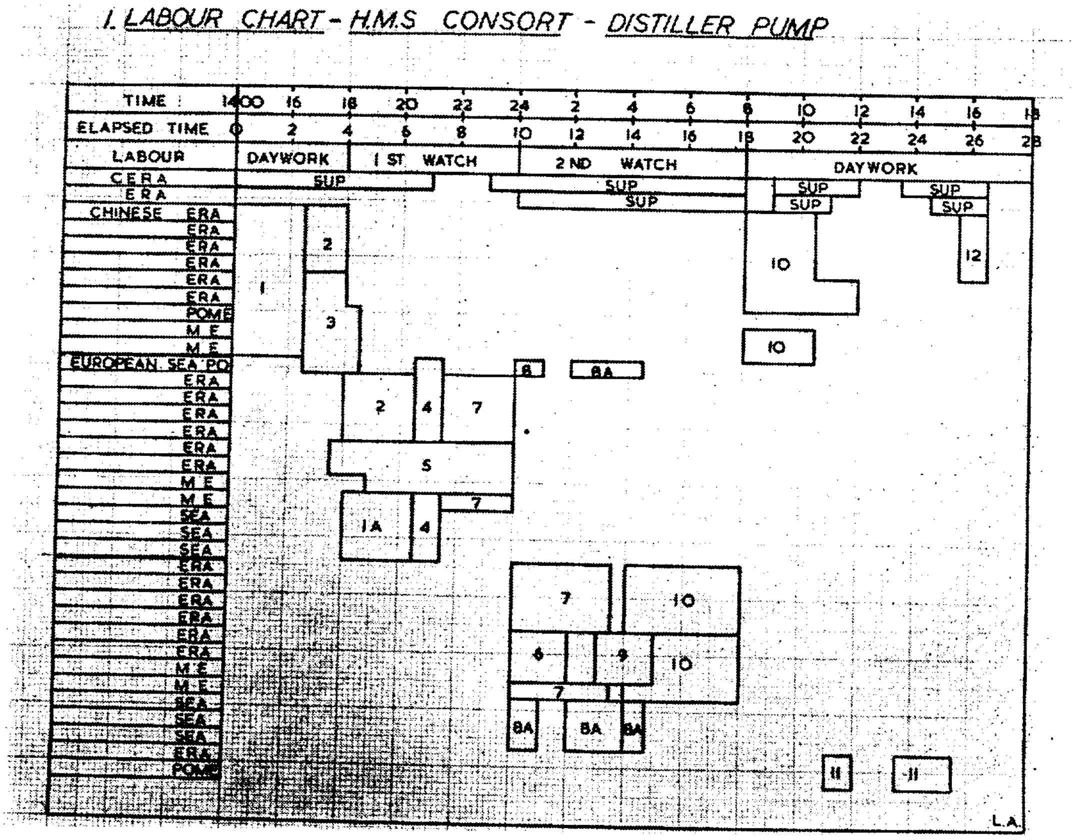
(*k*) Ship's staff repacked glands by 1630.

(*l*) On replacing the sea suction casting, it was found that the new pump would not face up, because the studs on the pump were the opposite angle. This entailed a delay of three hours, while the casting was cut and realigned to suit and then brazed, the operation being completed by 1430. Time elapsed 25 hours.

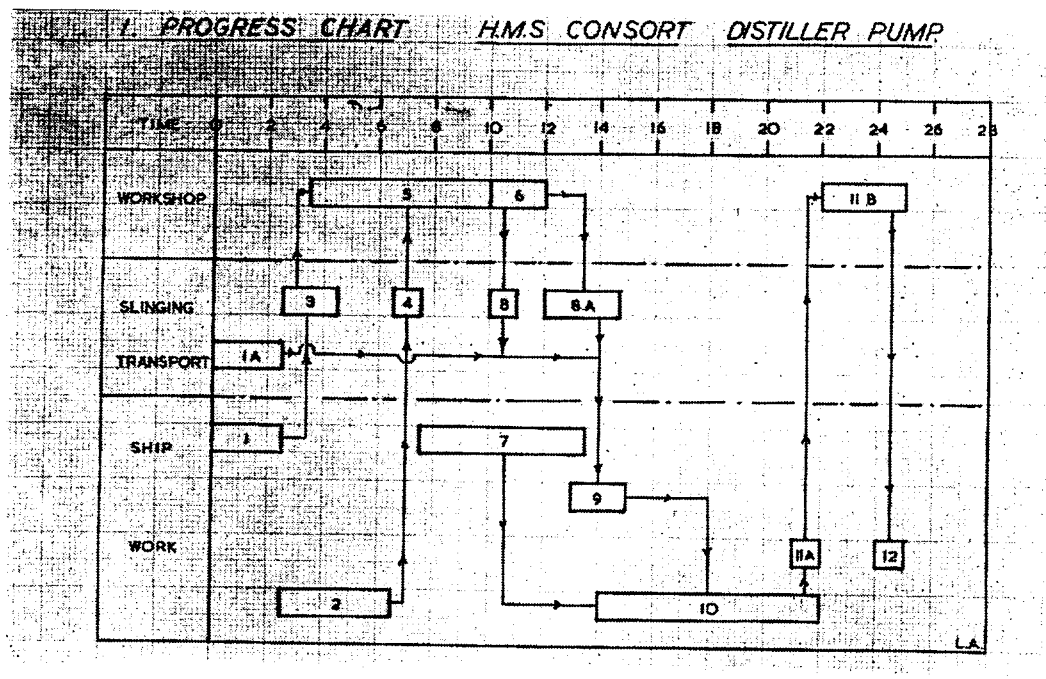
This job was 'man-houred' and Diagram I was produced to show how the job was done.

ANALYSIS—LIST OF WORK DONE

When	*What*	*When and How*			*Where*
No. of Operation	*Operation*	*Man-hours required*	*Men employed*	*Elapsed time in hours*	*Where done*
1	Break turbine joints, guard rails and clear for lifting	22½	9	2½	Ship
1A	Prepare for slinging	10	4	1½	Ship and Workshop
2	Break pump joints	16	4	4	Ship
3	Remove turbine to workshop	11	6	2	Ship and Workshop
4	Remove old pump to workshop	9	9	1	Ship and Workshop
5A	Unpacking new pump, cleaning flanges, etc.	4½	3	1½	Workshop
5	Align turbine to new pump and drill securing holes	12	3	4	Ship and Workshop
6	Drill and tap base holding holes	6	3	2	Ship and Workshop
7	Run down nuts and nuts and bolts, face flanges	30	5	6	Ship
8	Return turbine to ship	4	4	1	Ship and Workshop
8A	Return pump to ship and bed down pump and turbine	11	4	2¾	Ship and Workshop
9A	Prepare pump bed in ship	1½	2	¾	Ship
9	Align pump and turbine	4	4	1	Ship
10	Connect up pipes, replace guard rails, etc.	80	10	8	Ship
11A	Cutting pipe and spot-brazing in ship	2	2	1	Ship
11	Cut and braze casting to suit new pump	6	3	2	Ship and Workshop
12	Remake casting joints	2	2	1	Ship
	Totals	231½		43	
13	RAISE STEAM AND TRIALS Raise steam	18	6	3	Ship
14	Trials	12	6	2	Ship



Labour Chart I



Progress Chart I

Diagram I—How the Work was Done. The Operations are numbered as in the List of Work Done. 'Sup' means Supervision

LIST OF JOINTS, ETC. TO BE BROKEN

Steam	*Length of Pipe*	*Nuts, Bolts, etc.*	*No. of Pipes*
Supply	2 ft 9 in	10 in No : $\frac{5}{8}$ in nuts and bolts	1 : 2 flanges
Exhaust	7 ft 6 in	10 in No : $\frac{5}{8}$ in nuts and bolts	1 : 2 flanges
Throttle drain	5 ft	1 in No : $\frac{11}{16}$ in union nut	1 : open end
Exhaust drain	5 ft	1 in No : $\frac{11}{16}$ in union nut	1 : open end
Carbon packing drain	4 ft	1 in No : $\frac{7}{8}$ in union nut	1 : open end
Gauges, 3 in No. on brackets	4 ft : 1 in No. 5 ft : 2 in No.	2 in No : $\frac{1}{2}$ in nuts 3 in No : $\frac{3}{8}$ in union nuts 3 in No : $\frac{11}{16}$ union nuts	3
Turbine casing drain	4 ft	1 in No : $\frac{11}{16}$ union nut	1 : open end
Pump S.W. suction	1 ft 6 in	14 in No : $\frac{5}{8}$ in nuts 7 in No : $\frac{5}{8}$ in bolts	1 : 2 flanges
Pump discharge to distiller diluting system	11 ft 6 in 7 ft	12 in No : $\frac{5}{8}$ in nuts and bolts 8 in No : $\frac{5}{8}$ in nuts 4 in No : $\frac{5}{8}$ in bolts	1 : 2 flanges 1 : 2 flanges
Salt Water System			
S.W. circulating supply to oil boxes	3 ft	2 in No : $1\frac{1}{8}$ in union nut	1
S.W. circulating discharge from oil boxes	9 ft	2 in No : $\frac{7}{8}$ in union nuts	1
S.W. circulating between oil boxes	3 ft	1 in No : $1\frac{1}{8}$ in union nut 1 in No : $\frac{7}{8}$ in union nut	1
Fresh Water System			
Pump suction	7 ft 6 in	8 in No : $\frac{5}{8}$ in nuts and bolts 2 in No : brackets 4 in No : $\frac{1}{2}$ in nuts and bolts	1 : 2 flanges
Supply pipe to air pump	7 ft	2 in No : $\frac{3}{8}$ in nuts 4 in No : $\frac{5}{8}$ in nuts	1 : 2 flanges
F.W. discharge	5 ft	8 in No : $\frac{5}{8}$ in nuts and bolts	1 : 2 flanges
Brine System			
2 in No. brine strainers and change-over cock	1 ft 3 in	12 in No : $\frac{5}{8}$ in nuts and bolts	1 : 2 flanges
Brine discharge overboard	6 ft 6 in	10 in No : $\frac{5}{8}$ in nuts and bolts	1 : 2 flanges
Miscellaneous			
Deck plates : 4 in No.		14 in No : $\frac{3}{8}$ in screws	
Support brackets : 10 in No.		20 in No : $\frac{3}{8}$ in nuts	
Guard rails (2 sets)		11 in No : $\frac{1}{2}$ in nuts and bolts	
Ladder : 1 in No.		12 in No : $\frac{5}{8}$ in nuts and bolts	
Remove exhaust valve of M.F. pumps		8 in No : $\frac{3}{4}$ in nuts	
Remove vice bench		3 in No : $\frac{3}{8}$ in nuts and bolts	
Remove compound tank		4 in No : $\frac{5}{8}$ in nuts and bolts 2 in No : $\frac{1}{8}$ in union nuts	

TOOL ANALYSIS

This is obtained from the list of joints, etc., to be broken, and shows that there are :—

Size	*No. of Bolts*	*No. of Joints or Unions*	*Spanners per Joint*	*No. of Spanners Required (plus spares)*
$\frac{5}{16}$ in	4	1	2	3
$\frac{3}{8}$ in	24	6	2	12
$\frac{1}{2}$ in	13	3	2	6
$\frac{5}{8}$ in	126	25	2	(50) (18)
$\frac{11}{16}$ in	4	2	2	4
$\frac{3}{4}$ in	11	3	2	6
$\frac{7}{8}$ in	6	4	2	8
$1\frac{1}{8}$ in	3	2	2	4

Note

In the final plan, the number of men, restricted by confined space, is 14 working on joints, hence the maximum number of $\frac{5}{8}$ in spanners in use cannot exceed 14, plus an allowance of 4 as spares. The final figure is, therefore, 18 in number $\frac{5}{8}$ in spanners. This will relieve the bottle-neck on joints. Similarly, 126 in number $\frac{5}{8}$ in nuts and bolts will require 6 sets of $\frac{5}{8}$ in taps and die nuts, and 6 vices, to relieve another possible bottle-neck when running down nuts and bolts. It is doubtful whether this number of $\frac{5}{8}$ in spanners, dies and taps would be available in a destroyer, and repair ship assistance would be necessary.

Similar procedure will show requirement for hammers, Fox wedges, scissors, etc.

As only 4 tradesmen are used in the final plan, these tools would also have to be supplied, as tradesmen's tool kits are inadequate.

Analysis of these facts and Diagram I show that :—

(*a*) Breaking pipes, etc., took 34 man-hours, while replacing pipes took 62 man-hours. This is contrary to all experience as, in general, replacing with new bolts, joints, etc., takes 70 per cent of the time to break old bolts and joints. The conclusion to be drawn is, perhaps, that the men employed on this operation had reached a fatigue state as they had missed a night's sleep, and also number of $\frac{5}{8}$ in spanners available was insufficient.

(*b*) Running down bolts, etc., was started after turbine and pump were removed. This could have been done while joints were broken, thus gaining time. The number of $\frac{5}{8}$ in taps and dies and vices was also inadequate.

(*c*) There are several factors which govern operations :—

(i) The turbine must be mated to the new pump to effect alignment.

(ii) Workshop work, i.e. drilling securing bolt holes, tapping base holding stay bolt holes, and preparing pump flanges, must be done before the pump is bedded down in the ship. This work is the critical operation that decides the timing of all subsequent operations.

(iii) Steam pipes, etc., should be replaced first so that steam can be raised for testing.

(iv) Lack of suitable crane and transport increases time.

(*d*) Supervision at E.R.A. level is required throughout the job, but most of the work is within the capabilities of M.(E) ratings.

(*e*) Large numbers of $1\frac{1}{8}$, $\frac{7}{8}$, $\frac{3}{4}$, $\frac{11}{16}$, $\frac{5}{8}$, $\frac{1}{2}$, $\frac{7}{16}$, and $\frac{3}{8}$ in spanners, taps and dies, Fox wedges, hammers, files and scrapers are required (see Tool Analysis).

(*f*) Blocks and tackle must have a 30-foot lift, to save time wasted when additional tackle was required for short lifts.

(*g*) The watch system used was not suitable for the job because, in the way in which it was tackled, there was insufficient labour available for some operations, while on others there was more than could be employed.

SYNTHESIS

After analysing the job it is possible to produce Diagram II and, then, Diagram III.

In this plan it has been assumed that the ship's staff, with repair ship assistance, would carry out the job at the actual time it was undertaken, i.e. between 1400 and 0600 and allowance has been made for as many men as possible to have a few hours rest during the night.

It is obvious that 2 E.R.A.s and 1 P.O.M.(E) are employed for 12 hours without a break, and that a lower grade of skill could be used for some operations. Furthermore, operations 5A and 7 can be started earlier, and the man-hours for operations 1A, 1, 2, 5, and 7, can be reduced because, with repair ship facilities, additional tools would be available and less slinging would be necessary.

Hence, with an additional man, reducing labour skill to that required for each particular operation and assuming that flange alteration was unnecessary or was done in a workshop, Diagram III can be produced.

Diagram II is included in order to show an intermediate plan evolved before the final plan was achieved, because a succession of such labour and progress charts is essential to evolve the final plan. This plan must be flexible, make due allowances for ' snags ', provide adequate supervision, adequate skill, ' fetch and carry ' personnel, and, as far as possible, give a straightforward programme of work for each man.

AN EXAMPLE

Operation 7. Running down nuts and bolts and facing flanges.

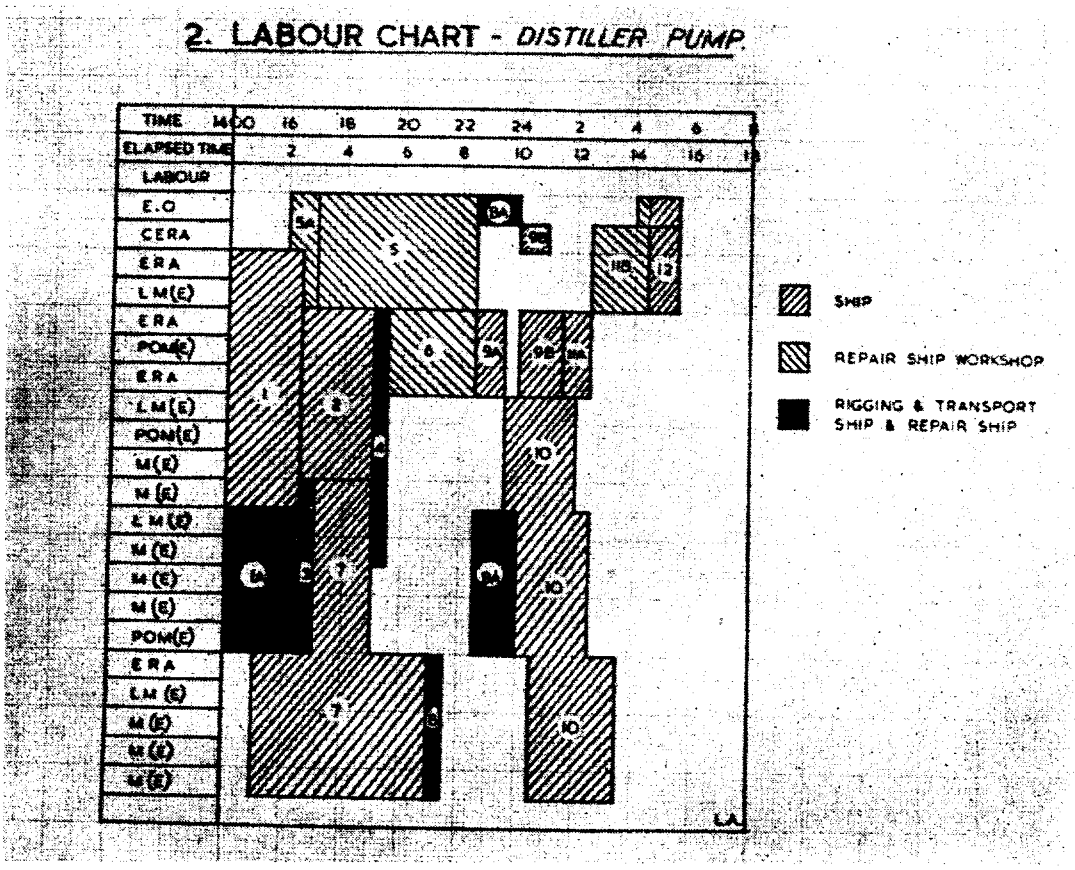
(i) Operation starts $\frac{1}{2}$ hour after work on pump joints (Operation 1) has begun.

(ii) 1st $\frac{1}{2}$ Hour—C.E.R.A. supervises and arranges traffic route (after hatch) for L.M.(E) and 2 M.(E)s to deliver pipes, nuts and bolts, to vices . (Upper deck vice, workshop, etc.).

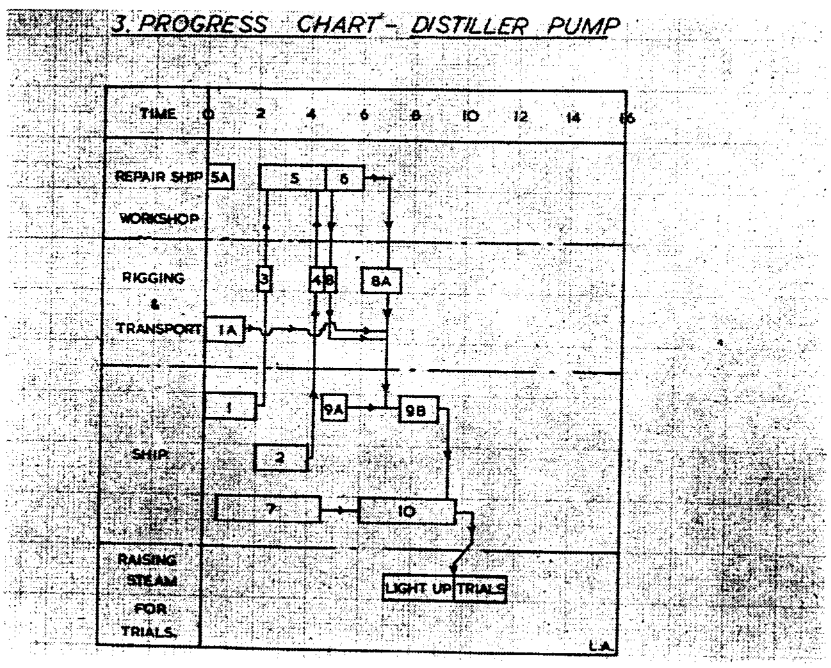
(iii) 2nd $\frac{1}{2}$ Hour—C.E.R.A. supervises :

1 L.M.(E) and 2 M.(E)s deliver pipes, etc.

1 E.R.A. and 4 M.(E)s man vices.

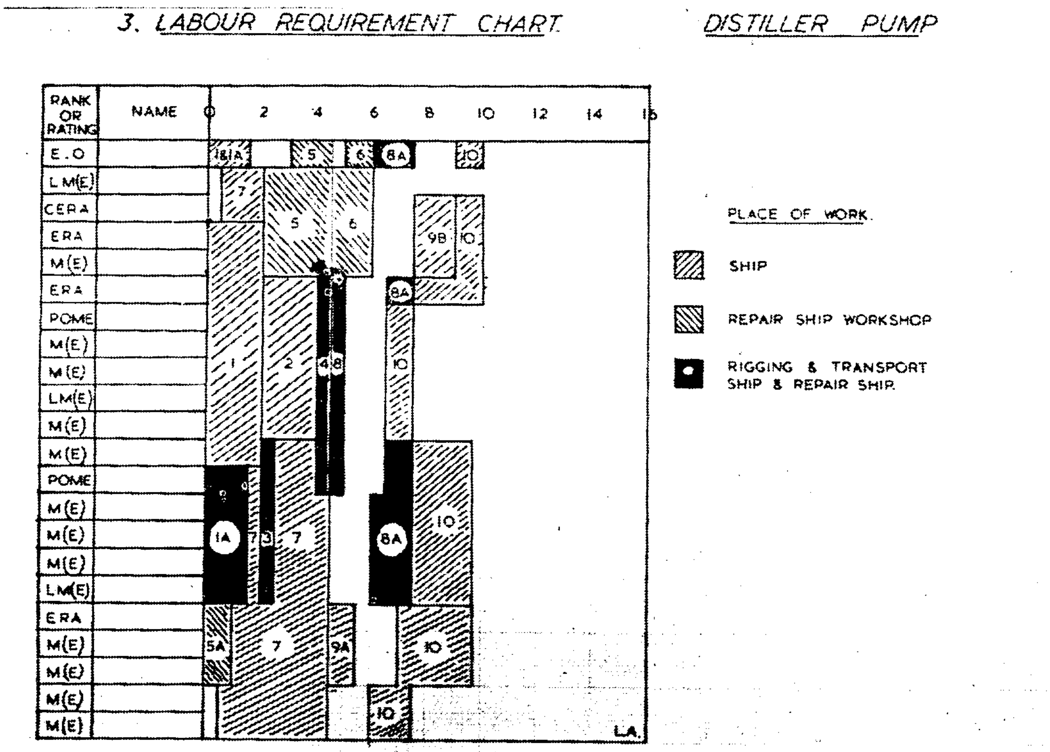


LABOUR CHART II

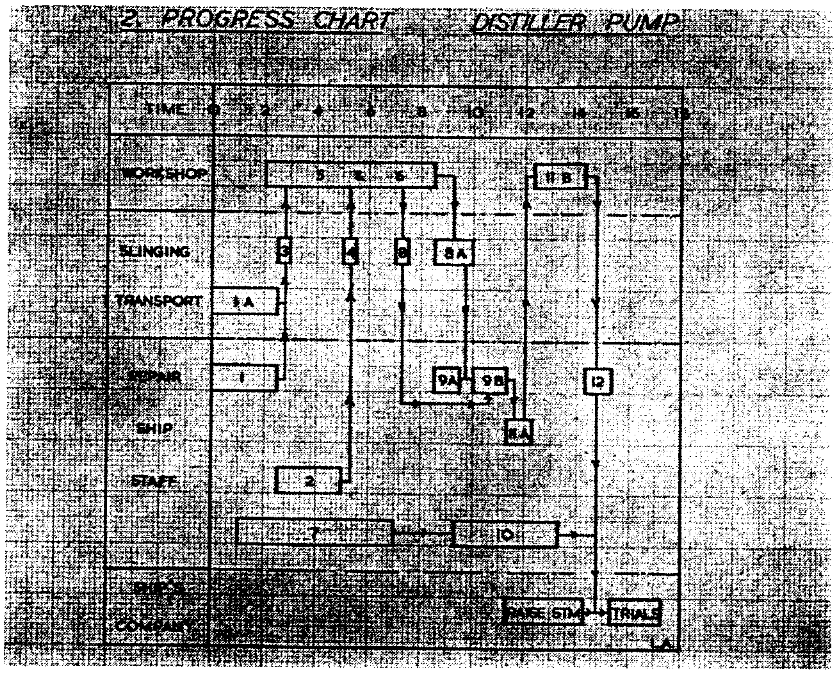


PROGRESS CHART II

DIAGRAM II—CARRYING OUT THE JOB USING PART OF A DESTROYER'S COMPLEMENT (21 MEN)



LABOUR CHART III



PROGRESS CHART III

DIAGRAM III—THE FINAL PLAN WHICH MEETS ALL REQUIREMENTS, EACH OPERATION BEING MANNED AND TOOLED AS NECESSARY

(iv) 3rd ½ Hour—C.E.R.A. supervises :

1 L.M.(E) delivers nuts and bolts, etc.

1 E.R.A. and 4 M.(E)s man vices.

2 L.M.(E)s and 1 P.O.M.(E) and 3 M.(E)s deliver pipes, etc.

(v) 4th ½ Hour—1 E.R.A. and 4 M.(E)s man vices.

(vi) 5th ½ Hour—1 E.R.A. supervises (having completed facing steam joints).

1 P.O.M.(E) and 4 M.(E)s on vices facing flanges, nuts and bolts, etc.

1 L.M.(E) and 4 M.(E)s cutting out joints, cleaning flanges.

(vii) Last ½ Hour—1 E.R.A. supervises :

1 L.M.(E) and 4 M.(E)s on vices.

3 M.(E)s cutting out joints, returning pipes to engine room.

Further, an example of how individual key ratings are employed to give a straightforward day's work : the P.O.M.(E) employed on operation 1A (i.e. rigging and slinging) is employed on all subsequent lifting operations 3, 4, 8 and 8A, and when not ' chief rigger ', is employed on preparing joints or connecting pipes (7 to 10) in the ship.

Diagrams II and III, are the synthesis, i.e. the putting together of actual man-hours taken on the job with the object of reducing the elapsed time, and spreading labour to avoid fatigue by allowing as many men as possible to have a rest. Each diagram gives a reduced elapsed time, but Diagram III shows that by concentrating labour where it can best be employed, namely running down bolts, preparing joints, and connecting pipes, the elapsed time for the job is considerably reduced. The final theoretical Diagram III shows how the job could be done if the following allowances are made :—

(1) A crane that could plumb the engine-room hatch, having a radius suitable to transport its lifts direct to the workshop or, at least, having proper and efficient transport to the workshop immediately available. As those transporting times are the fixed operations, relative to workshop work, on which all other operations depend when using repair ship or dockyard facilities, only half an hour should be required for each operation instead of the ' elapsed ' hours actually taken through lack of adequate lifting facilities. Thus, the whole sequence of operations moves forward, and final elapsed time is thereby reduced.

(2) A 50 per cent reduction of actual operation time to connect pipes, etc. This then conforms with experience and men, as employed in Diagram III, work shorter ' shifts ' and should not be fatigued.

(3) That flange alteration is not necessary, or is discovered in the workshop and remedied by altering the pump.

(4) That sufficient tools are available.

Method

From these diagrams a method for the job can be produced as shown in the specimen Job Card.

DISTILLER PUMP

TIME: Planned 10 hrs. *NOTICE FOR STEAM:* 16 hrs.

LABOUR REQUIRED: 1 E.O. ; 1 C.E.R.A. ; 3 E.R.A.s ; 2 P.O.M.(E) ; 3 L.M.(E) ; 12 M.(E).

TOOLS REQUIRED :

Spanners : 4—$\frac{5}{16}$ in ; 8—$\frac{3}{8}$ in ; 6—$\frac{1}{2}$ in ; 18—$\frac{5}{8}$ in ; 4—$\frac{11}{16}$ in ; 4—$\frac{7}{8}$ in.

Hammers : 14—2 lb ; 2—7 lb ; 2—copper ; 2—mallets ; 2—$\frac{1}{2}$ lb for joints.

Dies and Taps : (Sets) 1—$\frac{5}{16}$ in ; 2—$\frac{3}{8}$ in ; 2—$\frac{1}{2}$ in ; 12—$\frac{5}{8}$ in ; 1—$\frac{11}{16}$ in; 2—$\frac{3}{4}$ in ; 1—$\frac{7}{8}$ in ; 1—1$\frac{1}{8}$ in.

Screwdrivers : 2—$\frac{1}{8}$ in ; 2—$\frac{1}{4}$ in ; 6—$\frac{3}{8}$ in ; 2 × $\frac{1}{2}$ in.

Miscellaneous : Scissors—8 pairs ; chisels cross-cut—12 ; chisels flat—12 ; centre-pops—16 ; bench vices—5 ; electric pistol drills—2 ; electric pad drill—1 ; Fox wedges—30 ; oxy-acet. plant—1 ; blocks—2 half-ton ; 2 one-ton ; slings as necessary ; jointing material as necessary.

WORK TO BE DONE :

(1) Break turbine joints, guard rails
(1A) Prepare for slinging
(2) Break joint
(3) Remove turbine to workshop
(4) Remove old pump to workshop
(5A) Unpacking new pump, clean flanges, etc.
(5) Align turbine to new pump and drill securing holes
(6) Drill and tap base holding holes
(7) Run down nuts and bolts and face flanges
(8) Return turbine to ship
(8A) Return pump to ship and bed down pump and turbine
(9A) Prepare pump bed in ship
(9) Align pump and turbine
(10) Connect up pipes, replace guard rails, etc.

LABOUR CHART *PROGRESS CHART*

Charts from DIAGRAM III would be inserted here

Note.

(1) Ship must be berthed so that repair ship crane can plumb engine-room hatch.

(2) New pump must be made identical to old pump regarding flanges, studs, etc., in workshop. Delays in workshop, delay whole operation.

(3) All men get 1$\frac{1}{2}$ hours break in plan, but this is time which can be used to complete any delayed operation if required, i.e. 33 man-hours. Also there are 18 man-hours spare at end of job.

(4) Start job when engine-room is free of steam pressure, i.e. as soon as possible after shutting down, then raising-steam time is reduced.

(5) E.R.A.s to supervise all work.

Control

Exercised by engineer officer getting reports, inspecting progress and concentrating labour as situation demands.

This Job Card is a lay-out of one method of tackling the job. It is the result of reasoned conjecture, and represents a target to aim at. It should never be regarded as an inflexible maximum as regards time, for obviously, circumstances alter cases. It does, however, show how a replacement job can be reduced in time, and it gives a target time and specimen method of tackling the job.

Thus, the planning for this particular replacement, which had to be completed between 1300 Friday, 18th February and a.m. Monday, 21st February, shows that, with repair ship or dockyard facilities and labour, if planned, the elapsed time for the job, ex trials, is a minimum of 10 hours, and with ship's staff and workshop facilities, it can be done within 16 hours notice for steam. Consequently any engineer would be correct in forecasting 16 hours as the time required. The actual forecast made was 26 hours, but it was hoped to finish in 22 hours, and this jig-saw puzzle with man-hours, shows that, what was regarded from the time aspect as a creditable effort, could have been done in less than half the time.

This replacement example well shows how time can be saved, and, whereas the initial paperwork seems alarming, the final result is to reduce it, because all the necessary information can be got on to one piece of paper for all subsequent similar operations.

The example also shows the effect of a snag. The misaligned pump flange should have been discovered before the pump had been bedded down in the ship. It was probably overlooked, however, because the efficiency of the men on that particular phase of the operation had been reduced by fatigue, caused by the five hours overtime they worked during the night. The result was a 3-hour delay, or 17 per cent of the time for the job.

PERSONNEL FACTORS

The greatest difficulty in introducing this method of planning is to get cooperation from the ratings, and indeed some officers, for it is completely against British and Naval ideas of freedom in its widest sense, to be timed for any particular job of work, or to be given a set time for a job. Senior technical ratings resent being told how to do a job, and feel their competence as tradesmen is suspect. In consequence, lectures, talks and personal propaganda to key personnel is necessary, and their confidence must be won, so that, should they show only one hours work for a 7-hour day, there will be no come-back.

Bringing H.M.S. *Charity* out of reserve in 1949 in Malta, actually took 2 months. Every job was man-houred and planned, and afterwards a progress chart of how the work could have been done, with the complement allowed, was produced. This chart showed that working 10 hours a day, 17 days were necessary to complete an operation for which only 14 days were allowed. But, averaging out the actual hours the ratings worked, showed that the engine-room staff averaged 17 hours per week per man or about 45 per cent of the daily working hours.

The rating is well aware of this and is naturally reluctant to have it highlighted. A course of talks to all concerned was necessary before the co-operation to time jobs was obtained. But it was also noticeable in that operation, and in all subsequent planned jobs, that the ratings were delighted to beat the times set for the jobs. They soon acquired an interest and a competence that produced very creditable times.

The time allowance for jobs should be reasonable at first. If the men can beat the planner that is so much to the good and to their credit. If the planner is beaten it will lead to involuntary propaganda and a healthy competitive spirit. Future times for jobs can be reduced, and the times set will serve as an incentive to the man on the job. Upgrading mechanics on jobs increases their interest, and supervision by artificer ratings enhances the tradesman's status.

GENERAL APPLICATION

All engineers have some idea, from experience, how long various jobs should take. If a job is man-houred, then an analysis is possible on the lines set out above and a synthesis of the job can be made in the form of labour and progress charts. The next time that job is undertaken, charts can be corrected as necessary, and in general, the correction leads to a shortening of elapsed time.

The principles can be applied to any job in the Service, and the following are examples of preliminary guesses by the authors compared with final planned operation times since achieved with the facilities available.

(*a*) *Bulkhead Parallel Slide Valve*. Seized—(CO Class destroyers).

Preliminary estimate : 20 hours.

Planned time : 9 hours.

7 valves done—minimum time $8\frac{1}{2}$ hours ; maximum : 15 hours.

(*b*) *Gardner* 8*L*3. 1,000 *Hours Routine*. (2 engines in an H.D.M.L. engine-room).

Preliminary estimate : 16 days for 8 men.

Planned time : $4\frac{1}{2}$ days for 6 men.

8 sets done—minimum time : 3 days ; maximum : $6\frac{1}{2}$ days.

(*c*) *Patt*. 15221 *Table Fan*. Stripping down and replacing only.

Preliminary estimate : 30 minutes.

Planned time : 10 minutes.

7 fans done—minimum : 9 minutes ; maximum : 17 minutes.

These examples show how wrong one can be, and how much availability can be improved by adopting these principles.

It is hoped that this article may be of assistance to all who are interested in this subject, and that this example of the ' analysis of the obvious ', may lead to reduced repair or maintenance times.