MARINE ENGINEERING CRAFT TRAINING

BY

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Introduction

Craft training in the Marine Engineering sub-branch has evolved from the traditional craft apprenticeship to its current form as an element in the technicians' training scheme of technical training, education, and workshop practice. This evolution has taken place under the influence of changes in repair philosophies, in propulsion machinery, and with the demise of the comprehensive afloat workshop in large ships. The time allocated to the acquisition of craft skill has been reduced progressively to about 1500 hours for MEAs and 1000 hours for MEMNs.

Throughout this evolution, discussion on training objectives has been an emotive affair. The traditions of the craft apprenticeship that has served the R.N. so well and the varied personal experience of engineers at sea have tended to cloud the issues. For purposeful discussion there was a need to establish a definitive data base. This need was identified in the Engineering Branch Study (EBS) report and at the meetings of the Ratings Category Working Party (RCWP), and a joint study was therefore initiated by H.M.S. *Sultan* and H.M.S.

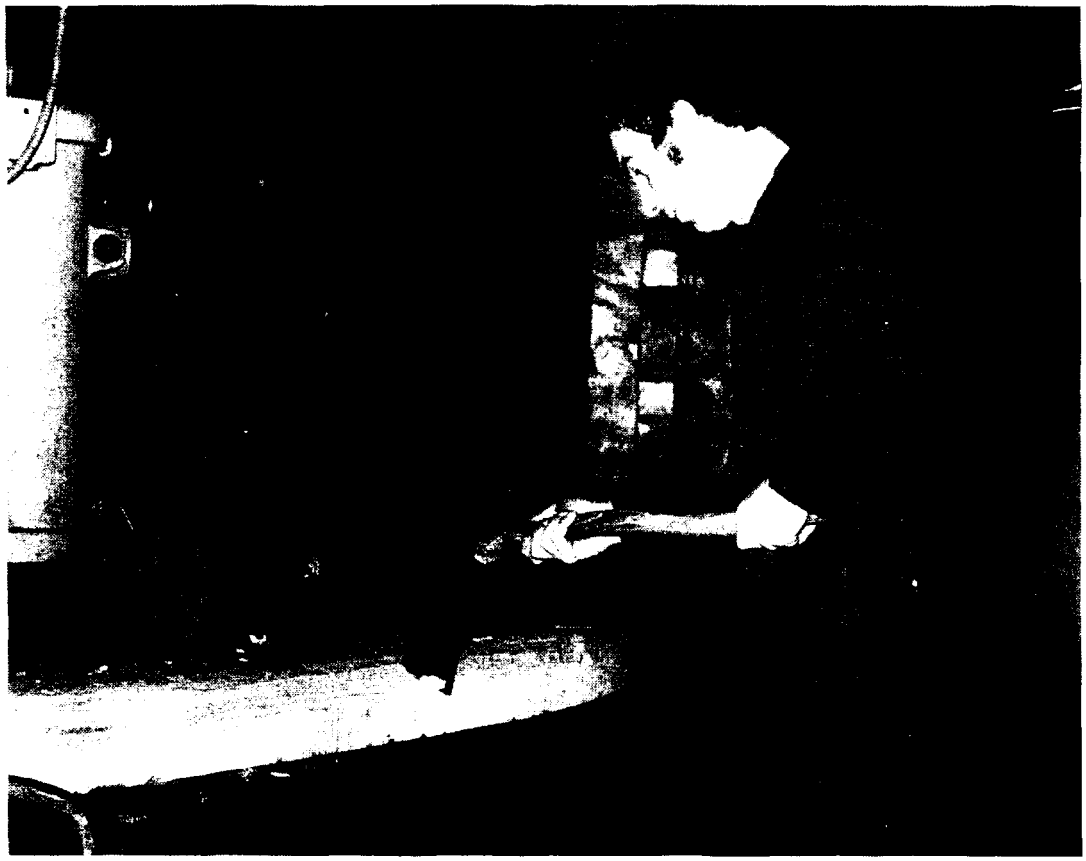

FIG. 1—ADZE, ANOTHER DIMENSION TO NUCLEAR ENGINEERING

Caledonia to identify the profile of skill used in the Fleet and support units to enable the formulation of training options.

This article describes the techniques used to identify these skills, the assessment made for establishing training time requirements, and the training recommendations made by the author for consideration by the two establishments.

Source Documentation

The craft skills employed in the Fleet can be identified by a number of techniques: direct observation of the work in hand, questioning personnel who have recently completed defect work, by interpretation of defect documentation, or by questionnaire. The latter technique is used by the Naval Manpower Utilization Unit (NMUU). The questions, however, need to be specially designed for each individual study if they are to be sufficiently discrete to specify precisely the skill and depth of skill used in the Fleet. Commander Keenan, during his Craft Investigation of 1969, used the second technique to good effect by questioning the personnel employed on the defect work reported on job cards in preceding months. In this present study, emphasis was placed on objectivity to ensure the validity of the data and it was agreed to concentrate the analysis on reported defects. The data was enhanced by including the direct observation of work undertaken by fleet maintenance groups (FMGs) and base support workshops during AMPs.

A total of 6653 ME and 1119 hull job cards for *Leander*s, Type 21s, and Type 42s were brought up from the archives at SMA Gosport (late SUIC) against a comprehensive equipment list prepared from the computer file at SMA. The tasks reported on the cards were batched by equipment, and the precise skills used in rectification of the defects were identified by experienced senior ratings with the aid of a matrix. The individual instruments, tools, techniques, and tests, listed in the columns of the matrix, were grouped into: ship and engine fitting, machining, metalwork, welding, joinery, boatwork, plastics, and floor coverings. The standard reporting of job cards is, however, infinitely variable. Texts are often inexplicit and on occasions are not filled in. One classic included 'Port boiler missing—Replaced by AMEE'! The analysis has therefore depended substantially on the interpretation placed on each task by the experienced MEA and MEMN analysts.

The quality of the data was enhanced by including the skills identified by direct observation of 363 jobs during AMPs for a GMD, Type 21, Type 81, MCMV, SSK, SSN, and a SSBN. Although this technique is the most objective, it is time consuming and the number of jobs observed was limited by the availability of manpower.

Results

Of the 100 000 job cards returned to SMA each year, about 15 000 are marine engineering and about 10 000 are hull. The total represents about three jobs per day per ship in commission and is considered to be low. Subjective estimates put the return at about 25 per cent. of the actual number of jobs undertaken. The ratio of ME:hull jobs reported is about 1·5:1. This is not considered to be representative of the division of jobs undertaken on board. Many ME jobs go unreported through the user/maintainer nature of their work, whereas cards are written by user sections throughout the ship to initiate 'hull' repairs.

The sample analysed is considered to be sufficiently large to draw up a comprehensive profile of craft skill although the incidence of use for each skill is not considered to be sufficiently accurate to make predictions on employment of personnel. The list is not exhaustive, clearly the 'once-in-a-commission job' will not have been identified. Nevertheless, sufficient jobs have been studied to formulate options for basic craft training on a more objective basis.

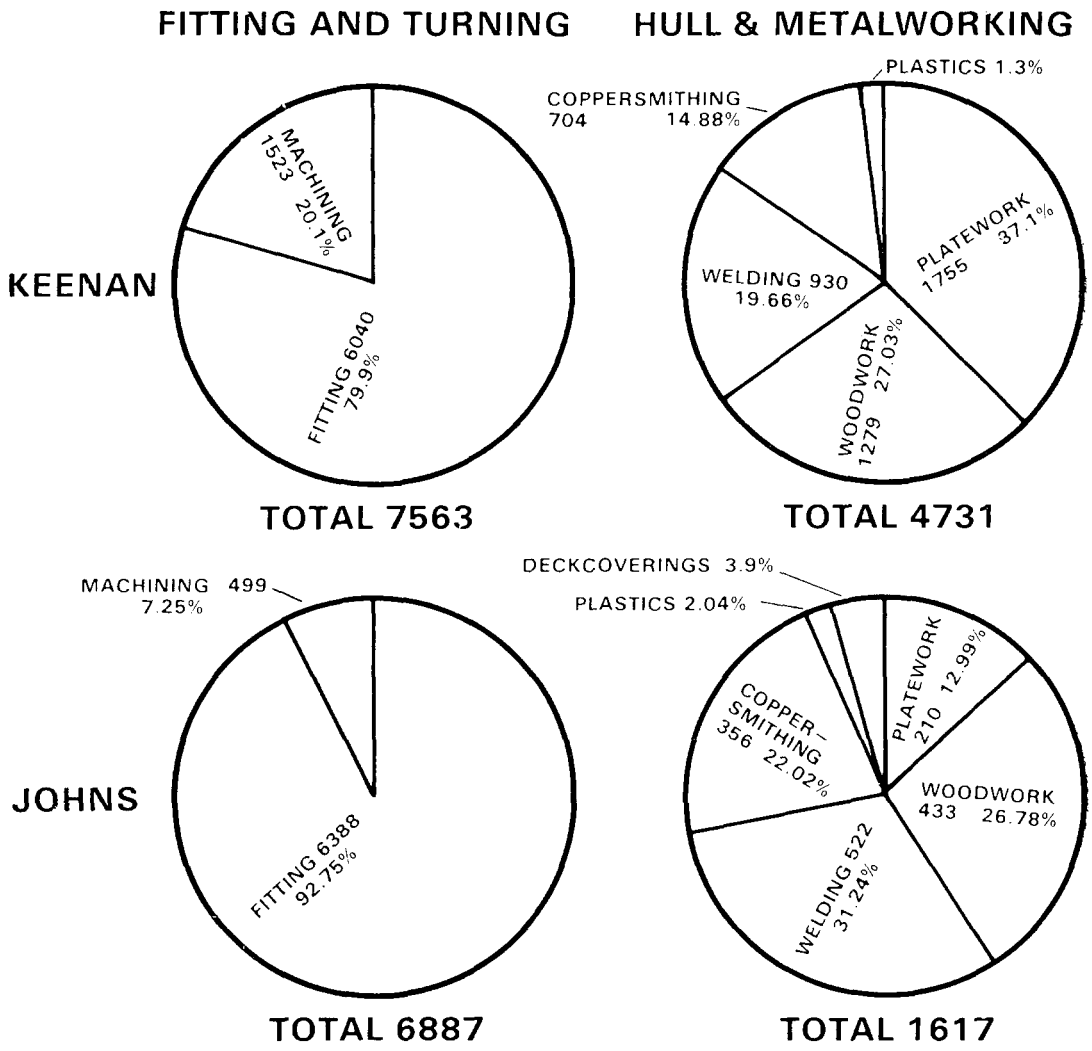

FIG. 2—CRAFT SKILL DISTRIBUTION

The incidence with which each skill was identified in the analysis is shown on the pie charts of FIG. 2 which compare the results with those of Keenan's investigation. The marine engineering and hull skills have not been combined on the diagrams due to the imbalance in the sample.

The analysis indicates clearly that the predominant employment is that of ship and engine fitting as defined by:

> the dismantling, inspection, repair, reassembly, and testing of a wide range of ship's machinery and systems using both hand and machine tools, basic metalworking and pipe working skills to meet a given performance specification;

an extensive range of skills that requires detailed knowledge of a wide range of equipments, considerable expertise and practice. The incidence of pure bench-fitting, the manufacture of mating components using hand tools, was small and has not been quantified separately. Comparison of the incidence of machining with that of Keenan shows a marked decrease. This may be attributed to inaccuracy of the sample selected, the interpretation placed on each task through poor reporting, or increased use of R by R components. Centre-lathe turning accounted for the majority of the machining. A small number of jobs in support workshops involved the use of milling machines, boring machines, and capstan lathes. The result for hull and metalworking skills shows a decrease in sheetmetalwork and an increase in coppersmithing, welding, and repairs to plastic materials. Woodworking has remained substantially the same.

The use of other skills—boilermaking, patternmaking, moulding and high-duty welding—was observed in FMG and base workshops. The number of personnel employed on this work is small but their employment is essential to the maintenance of the Fleet. The senior ratings trained and practised in these traditional deep skills are completing their service and there is an acute shortage of personnel for these billets. There is a need to provide specialist courses at H.M.S. *Sultan*, H.M. Dockyards, or possibly Engineering Industry Training Board (EITB) Skill Centres for a relatively small number of selected personnel. Arc welding has become a complex skill requiring substantial technical knowledge. It is no longer considered appropriate to include arc welding in basic craft training. MEAs are preoccupied gaining operator certificates on leaving H.M.S. *Caledonia* and can quickly lose their proficiency. Arc welding skills can be more economically imparted later on the specialist welding courses at H.M.S. *Sultan*.

Skill Specifications

Skill specifications have been written from the list of tasks identified and the histograms of the detailed matrix analysis. The specifications have been grouped into ship/engine fitting, machining, fabrication, and additional qualifications (adqual)/specialist skills and are written in sufficient detail for further course design work.

Training Analysis

The current training in craft skill was analysed against the profiles on the histograms. MEMN training was seen to lack sufficient breadth to enable MEMNs to undertake all of the ship and engine fitting tasks that arise; they rely in part on personal work experience built up at sea. The introduction of a basic metalworking module of some 150 hours in gas welding, sheetmetalwork, pipework, forging, and heat treatment would enhance their capabilities significantly. Although MEA(FT) training already includes elements of basic metal-working (106 hours), the MEAs' capabilities, however, could be improved by increasing this to about 200 hours with the inclusion of pipeworking skills.

The need to retain deep hull expertise, reconciled with the watchkeeping tasks, was recognized by the EBS and a Hull Adqual was started in H.M.S. *Caledonia* in 1977. Although experience of the 'Hull Adqualer' has yet to be accrued, and acknowledging the limitations placed on this analysis with data of insufficient accuracy to make employment predictions, the author considers that sufficient depth and quantity of 'hull' skills will be available to the MEO without the need for separate fitter and turner, and metalworker streams during basic craft training.

Time Estimates

The Workshop Training Sections in *Sultan*, *Caledonia*, and *Fisgard* have comprehensive programmes of in-course assessment based on a report by Commander Lowman in 1956. Although there are minor differences in each establishment, the assessment of trainee performance is based primarily on dimensional errors and the fits between mating surfaces. FIG. 3 shows typical results for Mechanicians' Qualifying Course (MQC) classes 140, 141, and 142. Trainee performance is expressed as the average error to which each class worked for the jobs shown on the horizontal time scale. The complexity of each exercise is exemplified by the number of dimensions and fits that must be measured to specify the inspection precisely. The 'spread' of error is shown by the standard deviation plotted for five jobs undertaken by MQC 140.

The accuracy to which the trainee works does not appear to improve during the course, being about 0·0023 inches throughout. The trainee does, however, undertake jobs of a more complex nature in a shorter time and is gaining

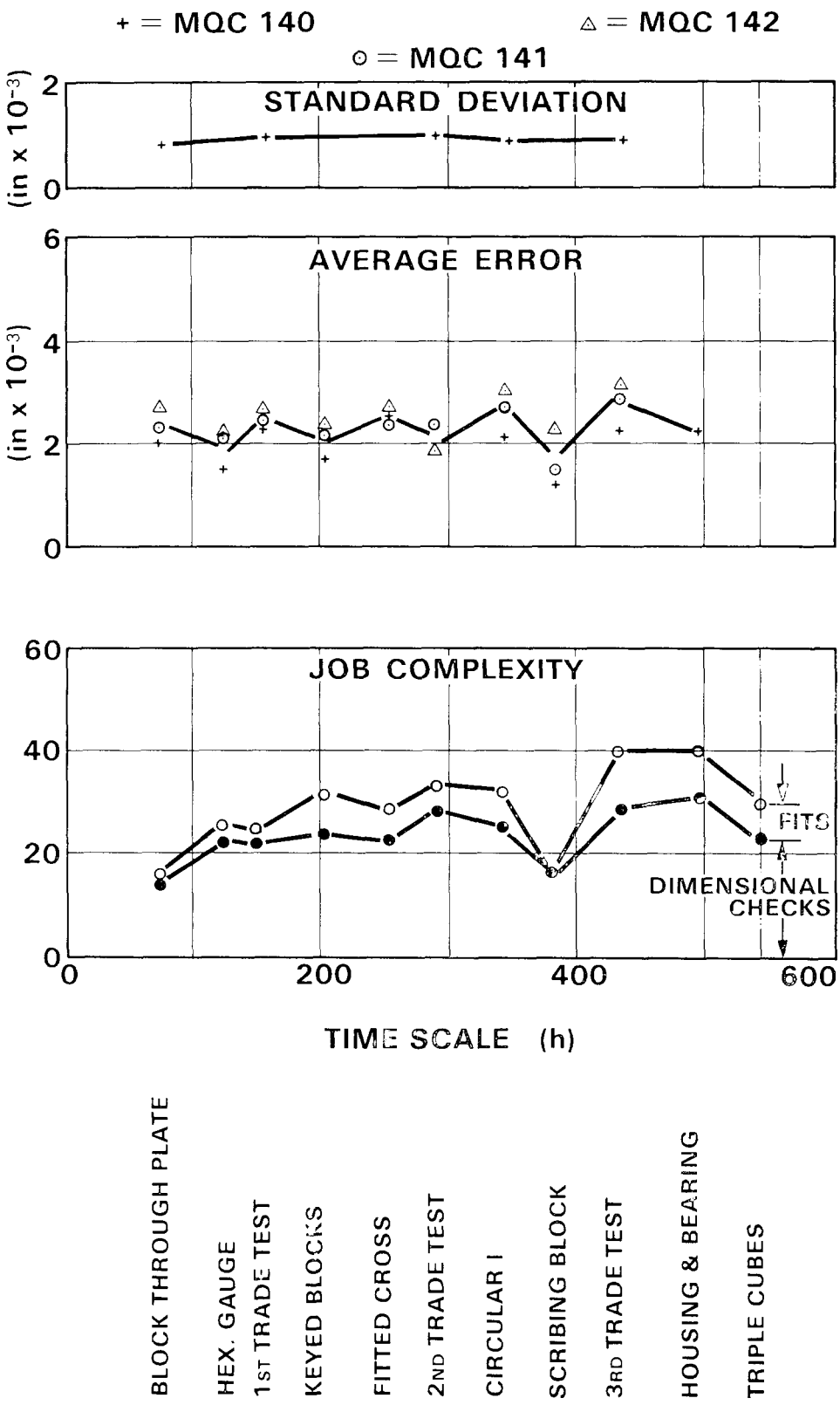

FIG. 3—MEMN BENCH-FITTING

confidence through experience. The level of direct supervision by the instructor has not been quantified but this decreases progressively as each trainee gains experience. The job complexity increases initially to a plateau of about 32 checks and fits after some 200 hours training. This is more complex than that identified in the analysis of defect work; the most complex job being exemplified

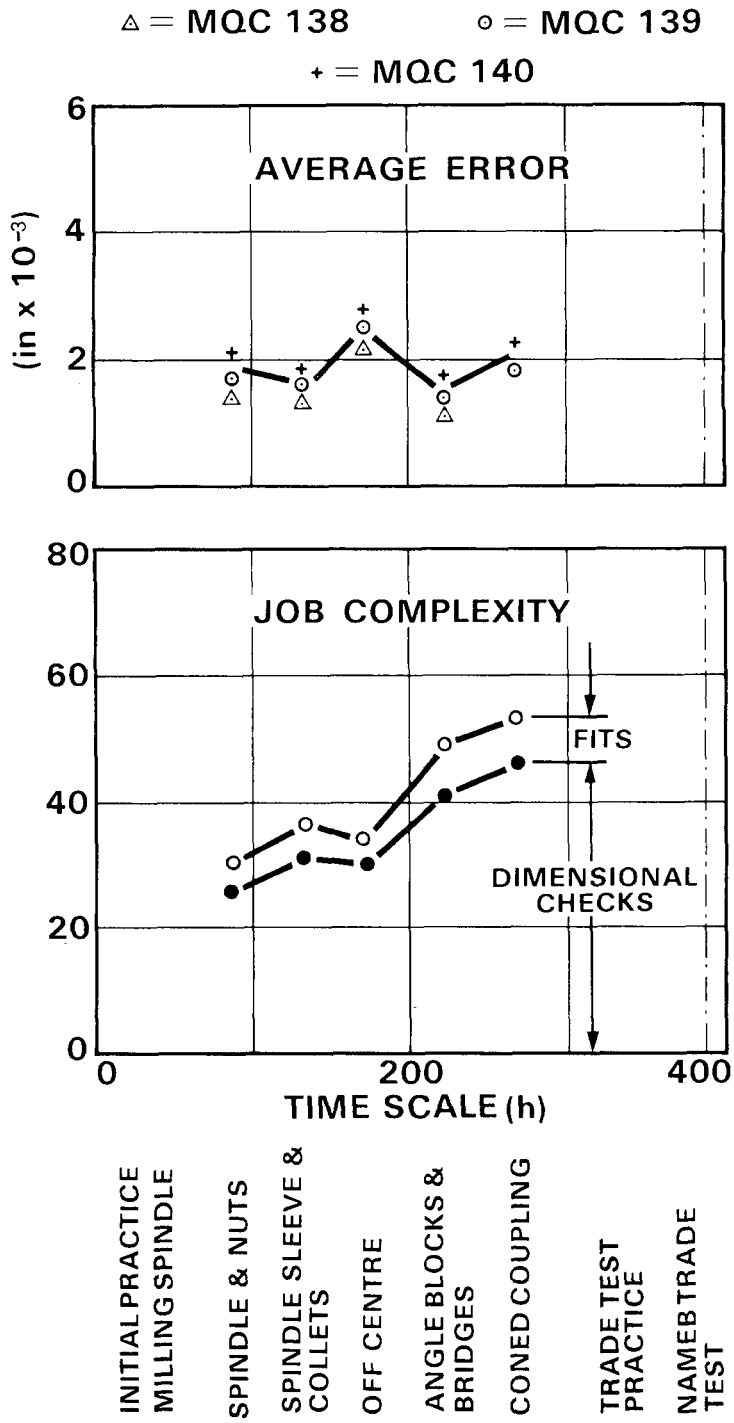

FIG. 4—MEMN TURNING

by the fitting of a key (6 dimensions and 4 fits). The high level taught is, however, considered necessary to provide the trainee with the foundation of skill of hand, confidence, and the craft acumen that is needed for further training, skill retention during operator training, and subsequent employment where he may be required to manufacture the 'once-in-a-commission component'. The point at which to terminate benchfitting training is difficult to assess and does require the application of a certain degree of informed opinion. In this case it is considered that time in excess of 350 hours does not contribute significantly to increased proficiency or confidence.

Examination of assessment records for machining shows that the 270 hours (see FIG. 4) spent by MEMNs on centre lathe turning is of the right order to

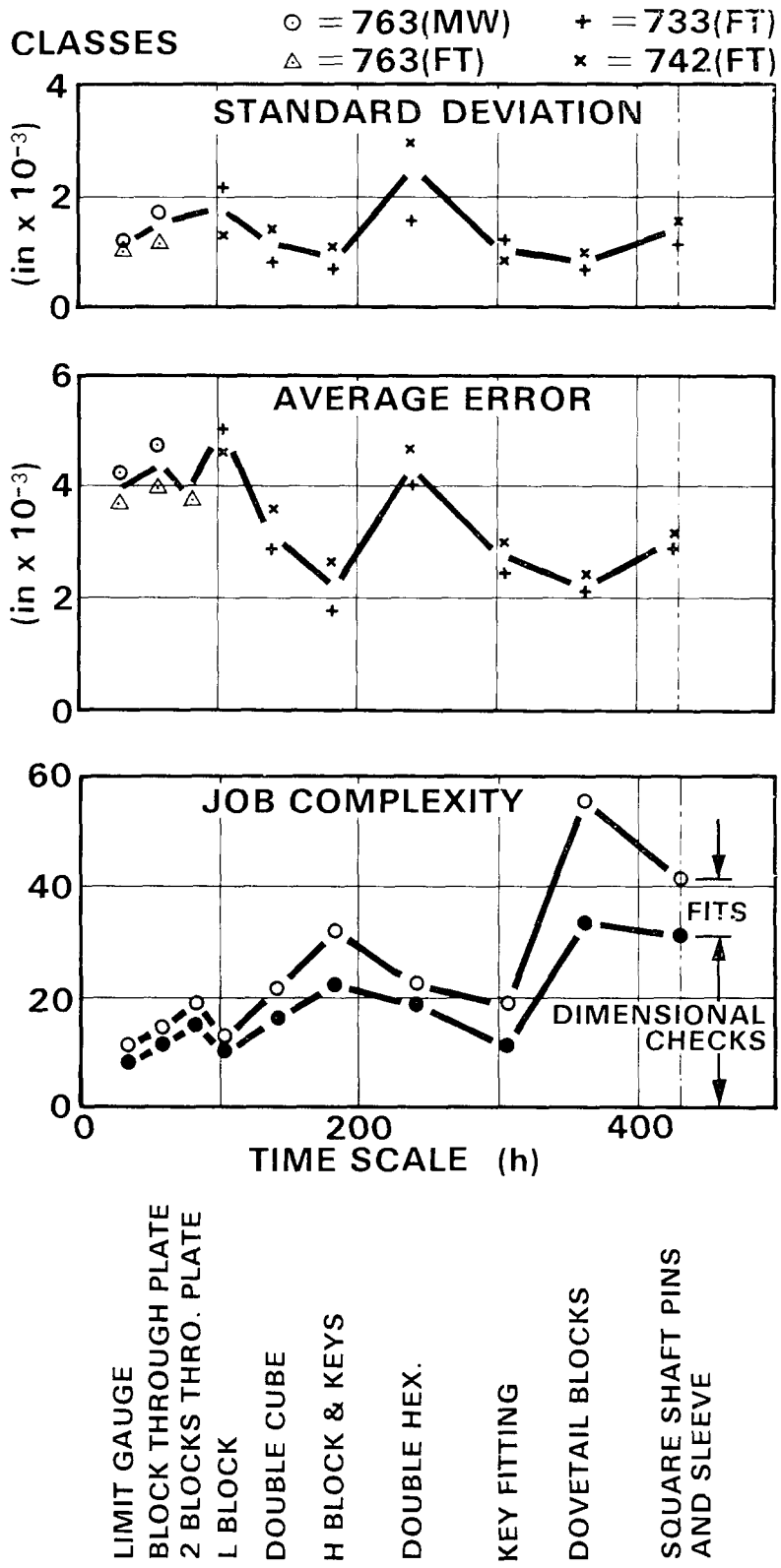

FIG. 5—MEA BENCH-FITTING

provide the 'foundation' machine skill for extension later to the other machine tools used in support workshops. Comparable estimates for MEAs are 400 hours benchfitting and 400 hours turning (see FIGS. 5 and 6). Here the graphs showed an 'exponential' improvement in skill as the course progressed with some scatter on returning from sea training. Time in excess of 400 hours was considered unproductive. Rather than striving to improve retentivity during

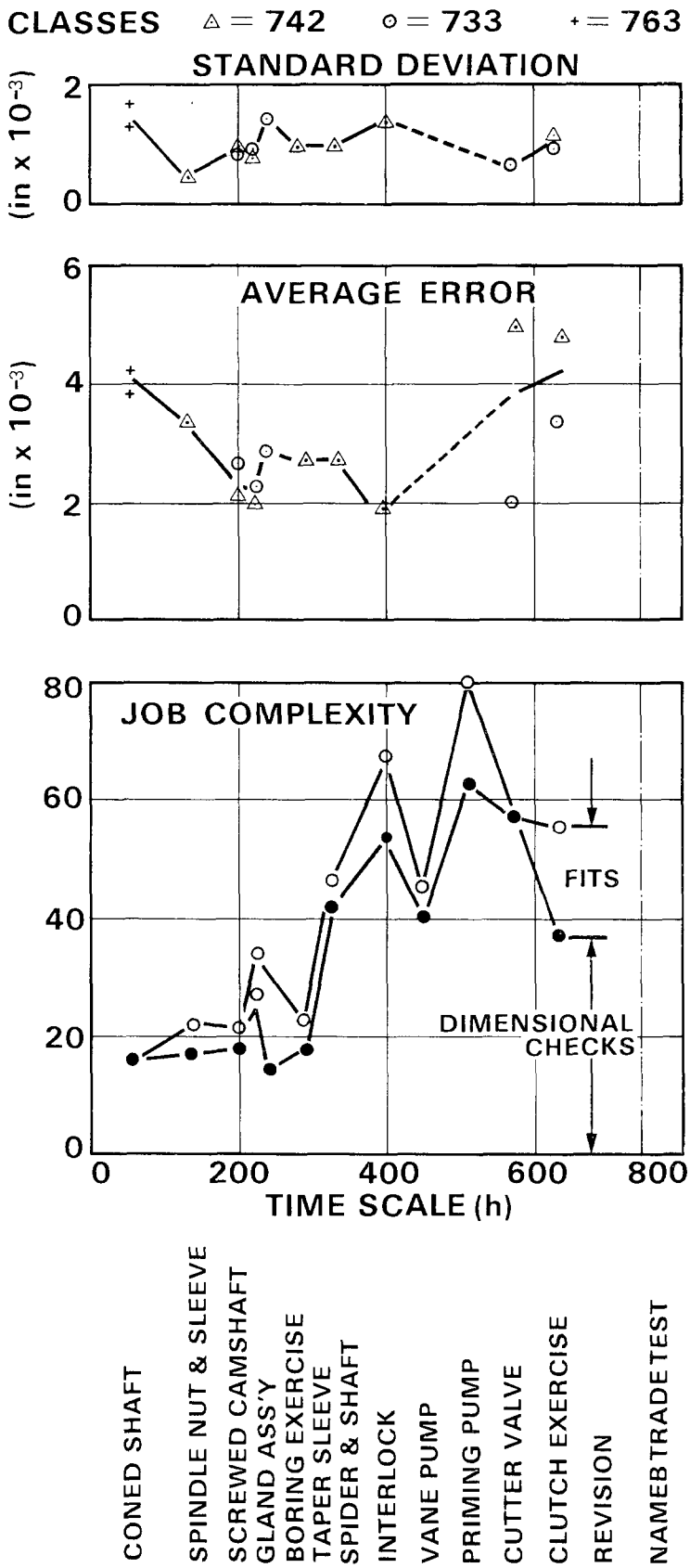

FIG. 6—MEA TURNING

subsequent operator training and employment at sea, it may be more advantageous to introduce short refresher courses for personnel drafted to support workshops.

Assessment and Moderation

The ongoing assessment of trainee performance in the workshops is truly objective and provides a continuous indicator of areas where extra tuition is warranted. The use of a formal trade test at the end of a course of training duplicates the comprehensive in-course assessment and provides information on performance too late for corrective action to be taken. The formal trade test is considered by the author to be a luxury and the time currently allocated to this test and its associated preparatory practice could be utilized more gainfully. The technicians' competence to undertake the breadth of skills identified in ship and engine fitting could be improved during this 120 hours. It has been pointed out to the author that formal trade tests help to motivate trainees and provide experience of working under stressing conditions. With a continuous assessment system, however, trainees are under pressure throughout the course and motivation should be maintained. If experience of working under stress is representative of the conditions encountered in the Fleet, this becomes a training objective and as such should be part of the training course.

A system of moderation is needed to ensure that the standards set are realistic of those in use in the Fleet and that the standards are achieved.

Conclusions

MEAs and MEMNs receive an excellent training in benchfitting and centre-lathe turning. Some engine fitting training is given but this is insufficient to enable them to undertake the breadth of tasks involved in ship and engine fitting without a substantial amount of on-job experience. Their competence could be enhanced significantly by increasing the time spent on training in metalworking and pipeworking. Compensating economies in workshop training time can be made by reducing the time spent on benchfitting and, for MEAs only, centre-lathe turning, without a loss of competence. The time allocated to formal trade tests and associated preparatory work is considered luxurious and could be more gainfully utilized broadening the trainees craft skills. The need for separate streams of metalworker and fitter and turner during basic training may well have been superseded with the introduction of the Hull Adqual. Specialist and Adqual courses are needed to ensure that the small number of specialist billets, so essential to the maintenance of the Fleet, are filled with competent personnel. The practicalities of reorganizing resources and manpower to implement the recommendations made are beyond the scope of this study. Further work is required before the findings can be accepted and incorporated in technicians' workshop training.

Acknowledgements

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