

# Craft Apprentice- ship in a Changing Society

## The Craftsman in History

1. Apprenticeship is again under the microscope and some of the key assumptions on which the craft system is based are being challenged. Increasingly the permanence that once underlined the occupational structures of society has itself given way to accelerating industrial change. The craftsmen of the past were proud men within a proud, tightly knit, brotherhood. The source of that pride was their skill, built up through a tradition of what we might call 'action learning', in and through the work itself. The traditional craftsman was autonomous with a strong identification with, and even ownership of, the product he created. As Parkin (1978) reminds us the design, the method of manufacture, the diagnosis and manufacturing solutions were almost entirely in his hands. He was a master of the whole job and had the skill and adaptive capacity to tackle any part of it. Consequently he was highly motivated, independent and resentful of interference from anyone outside the craft.

2. Through its Guilds and other groupings the craft system was self regulating. Tight supervision was exercised over entry of apprentices; the numbers and the standards required were a matter for internal control. In a very real sense technology developed from the adaptive ability of these early craftsmen.

3. Since the start of the industrial revolution there have been shortages of key skills. The problem of accurate prediction of the number and type of skills required for changing industrial situations has taxed some of the best analytical brains in the country and continues to do so. However, the more we try to understand the processes taking place, the more likely we are to get nearer to better solutions.

4. The situation today, therefore, of queries about standards, about length of time to learn and about the numbers under training and to be trained, and about methods of training, is not new.

5. Thus the Statute of Artificers in 1563 (Sections XXIV and XXVI) extended the system of seven year apprenticeship to the whole of the country; it prescribed the ratio of apprentices to journeymen and in effect limited the supply of skill, in the interest of job security and quality. As new crafts, skills and occupations emerged, however, although apprenticeship remained compulsory for occupations 'used within the Realm' (Section XXIV), the restrictions of the Statute produced hostility. Two hundred years later, Adam Smith (1776) criticised the fact that length of apprenticeship gave no security about workmanship and that its effects were undesirable as 'a young man naturally conceives an aversion to labour when for a long time he receives no benefit from it'.

6. It is interesting to note that three hundred thousand signatures were collected by workers representatives in 1813 to try to save the apprenticeship system developed in Elizabethan times (Mantoux 1927). Despite this the remaining provisions of the 1563 Act were repealed in the same year.

7. With changes in industry in the eighteenth century, little help was available from the education system, which itself was out of step with the needs of the economy. The solution emerged in the setting up of the Mechanics' Institutes. By the early 19th century, nearly every town had such an Institute. Subsequently, the further education system played an active role in the education of apprentices, usually with the help of enlightened employers.

8. At present, some of the aspects associated with the history of apprenticeship are again under debate and a case for change has recently been made out by the Engineering Industry Training Board (1978). This case for change is based on an analysis of the socio/economic situations related to apprenticeship.

## Engineering Apprenticeship Today

9. A brief description of the present engineering craft training system is now set out to help in understanding the subsequent analysis.

The present structure of craft apprenticeship was introduced by the Engineering Industry Training Board ten years ago. It consists of a first year of off-the-job training followed by a minimum of two modules of training and experience in selected groups of craft skills. In the first year the apprentice follows an approved course of training at a college of further education or an industrial training centre (either a company centre or a group training scheme centre). The two modules of training after the first year are usually undertaken on-the-job in a company.

The training usually takes three or four years to complete (one year off-the-job and two years or longer on module training) and Certificates of Craftsmanship are awarded by the EITB on satisfactory completion. Complementary further education is an essential feature of the craft apprenticeship and is arranged on the basis of day release or block release at a college of further education.

## The EITB's Analysis

10. Criticisms of the arrangements are made on five main grounds.

Firstly, the number of apprentices who reach satisfactory standards (i.e. two modules) in their training is inadequate to sustain the number of people employed as craftsmen. This judgment



allows for the fact that the number of engineering craftsmen is in fact slowly diminishing as the industry itself has undergone both contraction and restructuring. Table 1 demonstrates the change in the labour force.

Table 1 Changes in the Labour Force Covered by the EITB \*

| YEAR    | NUMBER OF CRAFTSMEN EMPLOYED | TOTAL EMPLOYEES |
|---------|------------------------------|-----------------|
| 1967-68 | 704,000                      | 3,372,000       |
| 1976-77 | 544,000                      | 2,934,000       |

\* Figures rounded to the nearest thousand.

11. Secondly, in times of economic difficulty some employers find themselves unwilling or unable to recruit apprentices. Their concern is invariably with immediate manpower problems and tactics, rather than with a manpower strategy for the future. The EITB has sought on five occasions in recent years to make up the difference between total industry needs and the actual recruitment by firms. It has done this by running Training Award Schemes, which aim to provide a first year of off-the-job training. At the end of the first year trainees are better placed to obtain continued training and employment in engineering. Whilst this has proved a useful mechanism, it suffers from the fact that continuation training cannot be guaranteed (and the wastage from the scheme is high).

12. Thirdly, during the 'Great Debate on Education' initiated in 1976 by the Prime Minister much attention was focused on the lack of effective links between school and work. Many school leavers have difficulty in coping with engineering craft training without remedial education, because of their limited skill in mathematics. Research sponsored by the EITB (1977) demonstrated that mathematical difficulties were mainly overcome in initial training, because of the increased motivation which resulted from the clear relevance of the mathematics to be learnt. Experience in industry training centres suggests that skills in mathematics and science are more readily acquired when they are related to practical applications and our research points to the beneficial effects of practical work in school in its own right.

13. Fourthly, there is much anecdotal evidence that the present four year apprenticeship no longer has the attraction for school leavers that it once had. The available range of careers is now much wider than it used to be and the engineering industry faces competition from what are seen as more attractive occupations. These attractions relate not only to pay but also to security and status. There is

also an increasing tendency to stay on at school beyond the statutory leaving age. While in some parts of the country which are experiencing severe unemployment, this part of the analysis at first sight may not seem persuasive, it must be recorded that in other parts there have been difficulties in recruiting potential trainees, even in times of unemployment. Looking ahead to the 1980s the Department of Education and Science (1978) predicts that the secondary school population will also decline significantly from 4.6 m to 3.4 m. This suggests that if the industry finds difficulties now, it will find increasing difficulty in recruiting when it seeks to respond to a more favourable economic climate.

14. Fifthly, firms are sometimes unable or unwilling or both, to train to the present craft standards. There are also industrial relations problems in using multi-skilled craftsmen even when they are available. Certainly, in terms of payment there is little significant difference between those who have been trained to the full standards and those who receive more limited or even minimal training.

#### Proposals for Change

15. The proposals of the EITB which are now under debate are based on changing the apprenticeship system as follows:

1) The attainment of craft status should depend on achieving standards, instead of on serving a fixed period of time.

2) A technical option should be provided in some schools. This would not only help to provide a more liberal education in its own right but also improve the relationship between schools and industry.

3) In consequence post-school industrial training arrangements should be revised so that off-the-job training facilities could be more concerned with particular skill development (module training) than with initial training.

4) The annual intake of apprentices should be planned by the EITB in conjunction with representative bodies of employers and trade unions, and supporting financial mechanisms should be developed to ensure the plan is achieved.

16. The new structure of training which could be applied to give effect to these proposals is now described below. At present this is the subject of widespread consultation and the final solution has yet to be determined.

#### Proposed Structure of Training

17. 1) Education during the last two years at school would be strengthened if a form of general education with a technical bias was available for those wishing it. The Board is in support of the intention expressed in *Education in Schools* (Department of Education and Science 1978) to improve the basic skills of mathematics,



science, technical knowledge and English and to give attention to the world of work. In particular it would welcome the development of courses in schools in which some stress is placed on applications at work of what is being learnt. It would accept that students who achieve a satisfactory grade (say CSE grade 2 or 3) in subjects in appropriately designed courses should be regarded as having reached standards approximating to those reached at present in the first six months of training in first year engineering training centres.

2) In industrial training after that stage it is suggested that existing first year centres should be converted to provide the basic skills of two modules. Module training would be completed by subsequent planned experience in the practice of the skills in the working situation. A system of continuous assessment and testing of performance would take place. On completion of the necessary standards and tests trainees would qualify for the Certificate of Craftsmanship and receive the appropriate craft rate of pay. This would not be awarded before the eighteenth birthday, although it must be emphasised that this does not imply the setting up of a two-year apprenticeship system. In any case it is not anticipated that many trainees would reach the standards required by the age of eighteen.

3) A regular intake of apprentices, in the numbers established as necessary to meet the industry's longer term requirements, would be determined each year. The number would be established in joint consultation with the Engineering Employers' Federation and the Confederation of Shipbuilding and Engineering Unions. If the aggregate of apprentices recruited by firms were less than the required number established by the Board, the Board would recruit and arrange for the training of the necessary numbers to make up the difference and would seek to secure their employment subsequently as craftsmen in the engineering industry. The costs of training such additional numbers would be met by a funding arrangement involving the Manpower Services Commission and the EITB. The EITB suggests that its share of the costs of such an arrangement would be established by retaining part of the levy on all firms in the scope of the Board which are liable to levy; the proportion retained would be related to the number of craftsmen they employ. Such a retention of money from levy is possible under the Employment and Training Act 1973 (Schedule 2) provided a majority of the employers affected agree.

#### Implications for Education

18. The implications of these proposals are significant for all the parties concerned, but in the remainder of this article I propose to concentrate on those which affect the secondary education system primarily. It is an intention of the proposals to encourage the wider development of broadly based programmes of education with an increased

emphasis on applicability to vocation. At the same time EITB believes that the educational features of the scheme would be of significant benefit to a wide range of students who would choose to enter careers *outside* engineering. The Board believes the proposals to be important for those whose aptitudes and inclinations show a bias towards technical studies with a practical emphasis.

19. Some severe criticism has been levelled at this part of the proposals on the grounds that at best it encourages too early specialisation and at worst it seeks to provide 'factory fodder'. A calmer more objective look at existing subjects offered for examination, through, say, the CSE, provides interesting information. Table 2 is a list of currently available non-engineering subjects which might equally be held to have a vocational element. One is not aware that a study of these subjects has aroused such vehement protests about their educational suitability in the secondary system.

20. Subjects with an engineering/technical bias are already offered. From the list in Table 3, one infers that many teachers and the CSE examining bodies have not seen these subjects as educationally damaging.

21. Fundamentally, no course of study can claim any position of ideal completeness and independence. An education which seeks only to develop disinterested intellectual or aesthetic appreciation is in error. As Whitehead (1962) says, essentially culture should be for action and its effect should be to divest labour of the association of aimless toil. The antithesis between technical and a liberal education is therefore a fallacious one. There can be no adequate technical education which is not liberal, and no liberal education which is not technical, that is, there is no education which does not impart both technique and intellectual vision. Or, in other words, education should turn out pupils with something they know well and something they can do well.

22. The proposals discussed in this article should make it possible for students to acquire proficiency in some skills and academic disciplines, to a standard that would enable them to take up a career in engineering, to start in the new apprenticeship structure and to achieve better continuity of learning between school and work. Certainly the EITB would wish its proposals to be judged by educationists against the criterion of whether they provide a good education in its own right.

23. It is hoped that the introduction of some learning objectives related to the world of work will help to motivate many who experience difficulty in appreciating the purpose of education in their later years at school. It should certainly provide an improved basis for careers guidance and the opportunity for teachers to gain better insights into and understanding of the attitudes and occupations of people in industry. If the proposals can be developed and carried forward jointly it will help those in industry to understand the value system of education and the practical problems of developing young people at school. In this way industry can use its influence to good effect.



Table 2:  
List of subjects with  
a strong vocational  
element.

| SUBJECT  | C.S.E. BOARDS OFFERING THE SUBJECT   |
|--|--|
| Computer Studies                                   | Associated Lancashire School; East Anglian<br>East Midlands; Metropolitan; Middlesex; North<br>West; Southern; South Western; Welsh; South<br>East; North; Yorkshire       |
| Shorthand  | East Anglian; East Midlands; Middlesex; North<br>West; Southern; West Yorkshire; West Midlands<br>Middlesex; North   |
| Shorthand Typing                                   | Associated Lancashire Schools; East Midlands;<br>North West; North   |
| Audio Typing                                       | Associated Lancashire Schools; East Midlands;<br>Metropolitan; Middlesex; North West; Southern;<br>West Yorkshire; South West; South East;<br>Yorkshire                    |
| Typing/Office Practice                             | Associated Lancashire Schools; East Midlands;<br>Metropolitan; Middlesex; North West; Southern;<br>West Yorkshire; West Midlands; Welsh; South<br>East; Yorkshire          |
| Office Practice                                    | Associated Lancashire Schools; Yorkshire<br>Associated Lancashire Schools; North West;<br>Southern; West Yorkshire; Northern; Yorkshire<br>Yorkshire                       |
| Office Practice with Audio Typing                  | East Anglian; Metropolitan; North West;<br>Southern; West Yorkshire  |
| Office Practice with Commerce                      | East Midlands; Metropolitan; Middlesex; North<br>West; Southern; West Yorkshire; West Midlands;<br>Welsh; North; Yorkshire   |
| Commerce with calculations                         | Associated Lancashire Schools; East Anglian;<br>East Midlands; Metropolitan; Middlesex; North<br>West; Southern; West Yorkshire; West Midlands;<br>Welsh; North; Yorkshire |
| Commercial Mathematics/<br>Commercial Calculations | Associated Lancashire Schools; East Midlands;<br>Metropolitan; Middlesex; North West; Southern;<br>West Yorkshire; West Midlands; Welsh; South<br>East; Yorkshire          |
| Accounts   | East Midlands; Associated Lancashire Schools;<br>East Anglian; Middlesex; North West; Southern;<br>South East  |
| Woodwork   | Associated Lancashire Schools; North West; Southern;<br>West Yorkshire; West Midlands; Welsh; South<br>East; Yorkshire   |
| Building   | Associated Lancashire Schools; East Midlands;<br>Metropolitan; Middlesex; North West; Southern;<br>West Yorkshire; West Midlands; Welsh; South<br>East; Yorkshire          |
| Surveying  | East Midlands; Associated Lancashire Schools;<br>East Anglian; Middlesex; North West; Southern;<br>South East  |
| Architecture, Construction and Design              | Associated Lancashire Schools  |
| Carpentry and Joinery                              | East Anglian; North West; Southern; West<br>Yorkshire  |
| Painting and Decorating                            | East Anglian; East Midlands; Associated<br>Lancashire Schools; North West; Southern<br>East Midlands; South East   |
| Trowelcraft  | East Anglian; North West; Southern; West<br>Yorkshire; Welsh   |
| Brickwork  | East Anglian; East Midlands; North West;<br>Southern, West Yorkshire   |
| Plumbing   | East Midlands<br>East Midlands   |
| Construction studies: mechanical                   | Associated Lancashire Schools; North West;<br>West Yorkshire; Yorkshire  |
| Construction studies: electrical                   | East Anglian; South East; Welsh  |
| Nursing  | Associated Lancashire Schools; East Midlands;<br>Metropolitan; North West; Southern; West<br>Yorkshire; Welsh; South East; Yorkshire<br>North West                         |
| Child Care and Nursing                             | East Anglian; East Midlands; Metropolitan;<br>Middlesex; North West; Southern; North;<br>Yorkshire   |
| Catering   | East Anglian<br>East Anglian; East Midlands; North West;<br>Southern; West Yorkshire; Yorkshire<br>East Midlands   |
| Nautical Catering                                  | Associated Lancashire Schools; East Midlands<br>East Midlands  |
| Nautical Studies<br>(navigation, seamanship, etc.) | South East<br>Metropolitan<br>South East<br>West Yorkshire   |
| Mechanised Arable Farming                          |  |
| Agriculture  |  |
| Retail Distribution/Retailing                      |  |
| Plastics/Plastic Design                            |  |
| Silversmithing and Jewellery                       |  |
| Enamelling and Jewellery                           |  |
| Small Offset Printing                              |  |
| Printing and Bookbinding                           |  |
| Mining Studies                                     |  |

Table 3:  
Technical subjects with  
a strong vocational  
bias.

| SUBJECT                                 | CSE BOARDS OFFERING THE SUBJECT   |
|---|---|
| Engineering Workshop Practice           | Associated Lancashire Schools; East Midlands; North West; Southern; West Yorkshire; Yorkshire   |
| Workshop Technology                     | East Midlands; West Yorkshire   |
| Metalwork/Sheet Metalwork               | Associated Lancashire Schools; East Anglian; East Midlands; Metropolitan; Middlesex; North West; Southern; West Yorkshire; West Midlands; South West; South East; North; Yorkshire        |
| Metalwork and Plastics                  | East Anglian  |
| Metalwork Design                        | West Midlands; Welsh  |
| Automobile Engineering                  | Associated Lancashire Schools; East Anglian; East Midlands; Metropolitan; Middlesex; North West; Southern; West Yorkshire; West Midlands; South West; Welsh; South East; Yorkshire        |
| Agricultural Engineering                | East Midlands; South East   |
| Nautical Engineering                    | North   |
| Foundry Engineering                     | East Midlands   |
| Fabrication Engineering/Welding         | Associated Lancashire Schools; East Anglian; East Midlands; North West; Metropolitan; Southern; West Yorkshire; South East  |
| Machine Shop Engineering                | East Anglian; East Midlands; North West   |
| Light Engineering                       | East Anglian  |
| Engineering/Engineering Studies         | Associated Lancashire Schools; East Anglian; East Midlands; Metropolitan; Middlesex; North West; Southern; West Yorkshire; South East   |
| Mechanical Engineering                  | East Anglian; East Midlands; North West; Southern; South East; Yorkshire  |
| Electrical Engineering                  | East Anglian; East Midlands; Metropolitan; Southern; West Yorkshire; Welsh; South East  |
| Engineering Technology                  | West Yorkshire; Yorkshire   |
| Fitting and Turning                     | Associated Lancashire Schools   |
| Mechanical and Electrical Installation  | Associated Lancashire Schools   |
| Electrical Installation                 | East Anglian; North West; Southern; West Yorkshire; Welsh; South East   |
| Applied Electricity                     | East Midlands   |
| Electronics                             | Associated Lancashire Schools; East Anglian; East Midlands; Metropolitan; North West; Southern; West Yorkshire; Welsh; Yorkshire  |
| Aviation/Aeronautics                    | Associated Lancashire Schools; East Anglian; East Midlands; Middlesex; Southern; Yorkshire  |
| Control Technology                      | Associated Lancashire Schools; East Anglian; East Midlands; North West; Southern; West Yorkshire; Welsh; South East   |
| Basic Technology                        | Associated Lancashire Schools; East Anglian; East Midlands; West Yorkshire  |
| Craft Technology                        | Southern  |
| Polymer Design and Technology           | South East; Middlesex   |
| Technical Drawing                       | Associated Lancashire Schools; East Anglian; East Midlands; Metropolitan; Middlesex; North West; Southern; West Yorkshire; West Midlands; South West; Welsh; South East; North; Yorkshire |
| Geometrical and Engineering Drawing     | North West; West Yorkshire  |
| Geometrical and Building Drawing        | North West  |
| Geometrical and Woodworking Drawing     | North West  |
| Engineering Design                      | East Anglian; East Midlands   |
| Engineering Drawing and Auto Technology | West Yorkshire; West Midlands   |
| Design and Technology                   | East Anglian; Yorkshire   |
| Integrated Craft and Design – wood      | North West; Welsh   |
| Industrial Design/Engineering Design    | Southern  |
| Materials and Design                    | Yorkshire   |
| Technical Studies                       | West Yorkshire; Yorkshire   |
| Engineering Maths                       | West Yorkshire  |



24. The EITB suggests in its proposals that it should be possible for some school leavers to reach standards approximating to those achieved in the first six months of an industrial training scheme. The Board reached this view by looking at the learning objectives for the first half of a typical existing first year training programme as set out in Appendix A. These objectives are purely illustrative of what is attained in a responsible training centre and they are in no sense presented as an outline syllabus for a school course. At the same time we have studied in detail a number of school syllabuses of various CSE examining boards in England and Wales and of the Scottish CE. These syllabuses show a greater degree of similarity with our objectives than might have at first seemed possible. It is clear that the example objectives set out in Appendix A could be achieved through a variety of combinations of CSE/GCE or SCE courses in the general fields of mathematics, applied science, technology and craft practice. We hope that it will be possible to arrange joint discussions with teachers to consider how equivalent standards can be achieved, and it should be possible to develop a good deal of local flexibility, while, at the same time, ensuring that the required standards are achieved by school leavers who wish to enter the new pattern of engineering craft apprenticeship. Obviously the Board would need to be satisfied that the assessment of practical craft work ensured the necessary credit to apprenticeship.

25. In the development of courses, it is hoped that the Board will be enabled to play a constructive role to the benefit of education and of the students and that new opportunities will be found to improve the industrial relevance of courses. Linked schemes between schools, colleges of further education and

industrial training centres could take on a new and more purposeful role. If it were thought helpful, the Board would seek to provide teaching material and advice on the engineering aspects of the school courses.

26. The new structure of apprenticeship would, it is believed, increase the incentive to learn quickly. Relating pay to the achievement of standards should have a beneficial effect on attendance and performance in further education. There should also be a substantial reduction in the number of apprentices who do not at present receive the formalised training which should accompany their further education. The present pattern of further education courses would also need to be reviewed in the light of the changes proposed.

27. The recent 'Great Debate on Education' in part reflected a mood of the population that all was not well. Indeed when one considers the education and development of the nation's young, the frustrated hopes, the limited careers which result and which arise from the ignorance and prejudice with which the subject may too often be treated, it is difficult to remain calm. If we do not encourage a value system which recognises the importance of craft for its own intrinsic worth, as well as for society, then we face a bleak future, since it affects the wealth-creating part of our society. There will be no appeal from the judgment of the nation if attainable knowledge for its young people that could have changed the issue has not been made available.

28. At least here is one response to the challenge of coming together in the interests of the young in particular. It is made in the belief that we have, in industry and education, more in common than that which divides us. I hope industry and education will take up the challenge together.

# Operation Axoplan

H.E. Dance

It is possible to use the set of axogrids which was published on the back cover of the Spring 1978 edition of this Journal without using measuring scales for the vertical displacements. See fig. 14 of the article in which the levels of the various features were gauged 'by eye'. However, to gain the full advantage of Axoplan the levels should be measured by scale which was omitted from the set of axogrids on the cover of volume 10.2. It is printed below so that it may be attached to the cover if so desired.

It is axoplan practice to mark the grids by dots every five lines to facilitate the counting of lines. It is left to the student to mark the grids he chooses to use in any convenient scale of measurement.

Notice that the five increments of radius in the set of ellipses corresponds to five spaces between lines in the grid which represents squares.



## APPENDIX A

### LEARNING OBJECTIVES FOR THE FIRST HALF OF A TYPICAL EXISTING FIRST YEAR PROGRAMME FOR ENGINEERING CRAFTSMEN

1. Objectives concerned with understanding engineering terminology and the way in which engineering instructions are indicated through drawings.

The Trainee should be capable of:

- producing pictorial sketches of simple components
- producing simple component drawings in first and third angle projections
- producing simple drawings which include hidden detail
- producing simple drawings which include sectional elevations
- identifying and stating the use of general arrangement drawings, sub-assembly drawings and detailed drawings
- reading a simple component drawing and extracting information about the type of material required, the size and shape of material required, the limiting dimensions and tolerances, and the quality of surface finish required
- reading a simple electrical drawing

2. Objectives concerned with understanding industrial systems of measurement and the use of standard measuring instruments.

The trainee should be capable of:

- measuring components using imperial and metric rules
- checking micrometers and verniers for zero reading
- using imperial micrometers (external)
- using metric micrometers (external)
- using imperial vernier calipers (external)
- using metric vernier calipers (external)
- using imperial micrometers (internal)
- using metric micrometers (internal)
- using imperial vernier calipers (internal)
- using metric vernier calipers (internal)
- using imperial depth micrometers
- using metric depth micrometers
- using imperial depth verniers
- using metric depth verniers

3. Objectives concerned with the acquisition of basic skills in mechanical fitting, milling and turning.

In mechanical fitting, the trainee should be capable of:

- using a bench vice
- filing flat and square to 0.001 inch/inch or 0.025mm/25mm
- filing to a dimensional tolerance of  $\pm 0.005$  in. or 0.12mm
- marking out to  $\pm 0.005$  in. or 0.12mm
- hacksawing
- filing profiles to  $\pm 0.010$  in. or 0.25mm
- filing to obtain a surface finish of 32 CLA N6
- using a machine vice

- clamping workpieces
- operating drilling machine controls
- selecting speeds and feeds for drilling
- drilling to a positional tolerance of  $\pm 0.010$  in. or 0.25mm

- countersinking
- using cold chisels
- machine reaming
- hand reaming
- cutting internal threads by hand
- cutting external threads by hand

In milling, the trainee should be capable of:

- operating the machine controls
- using a machine vice
- mounting cutter to a horizontal machine
- mounting cutter to a vertical machine (stub arbor)
- selecting given speeds and feeds
- milling flat and square
- milling to  $\pm 1/64$  in. or 0.4mm (vertical)
- milling to  $\pm 1/64$  in. or 0.4mm (horizontal)
- facing to length, tolerance of  $\pm 1/64$  in. or 0.4mm (vertical)
- facing to length, tolerance of  $\pm 1/64$  in. or 0.4mm (horizontal)
- selection, setting and use of collect chucks
- milling a slot, tolerance  $\pm 0.005$  in. or 0.12mm (vertical)
- milling a slot, tolerance  $\pm 0.005$  in. or 0.12mm (horizontal)

- milling a shoulder, tolerance  $\pm 0.005$  in. or 0.12mm (vertical)

- milling a shoulder, tolerance  $\pm 0.005$  in. or 0.12mm (horizontal)

- using a form relieved cutter

In turning, the trainee should be capable of:

- operating centre lathe controls
- using a four-jaw chuck for cylindrical work
- selecting given speeds and feeds
- facing to lengths  $\pm 1/64$  in. or 0.4mm
- taper turning compound slide  $\pm 1/64$  in. or 0.4mm

- drilling (centre drills)
- using driving plate and lathe centres
- turning to lengths  $\pm 1/64$  in. or 0.4mm
- turning external diameters  $\pm 0.002$  in. or 0.05mm

- using a three-jaw chuck
- grooving (external)
- knurling
- drilling (twist drills)
- machine reaming
- boring: tolerance  $\pm 0.002$  in. or 0.05mm
- grooving (internal)
- parting off  $\pm 0.015$  in. or 0.40mm

4. Objectives concerned with the acquisition of basic skills in sheetmetal work and welding.

In sheetmetal work, the trainee should be capable of:

- marking out
- cutting metal to shape using snips or bench shears
- drilling machine controls
- cutting metal to shape using cold chisels
- drilling
- operating a treadle or power guillotine
- cutting metal to shape (treadle or power guillotines)
- bending metal to size using folding machines
- using portable power tools
- producing a folded safe edge
- producing a wired safe edge
- riveting mating parts
- resistance spot welding
- producing a self-secured joint (square work)
- producing a soft-soldered joint
- producing a simple assembly

In electric arc welding, the trainee should be capable of:

- operating the welding set controls
- connecting welding leads
- selection and fitting of electrodes
- selection and regulation of electric current
- striking the arc
- deposition of fusion beads (flat position)
- non-destructive testing of welds
- tee fillet joint (single run flat position)

In oxy-acetylene welding, the trainee should be capable of:

- selecting and connecting the regulators
- identifying and fitting the hoses and blowpipes
- selecting and setting working gas pressures
- testing for gas leaks
- lighting and adjusting the blowpipe flame
- produce fusion beads on mild steel plate without filler
- closed outside corner joint (flat position)
- produce fusion heads on mild steel plate with filler
- non-destructive testing of welds
- bronze fillet weld lap joint (flat position)

In oxy-fuel gas cutting, the trainee should be capable of:

- selecting and connecting the regulators
- identifying and fitting the hoses and blowpipes
- selecting and setting working gas pressures
- testing for gas leaks
- lighting and adjusting the blowpipe flame
- hand cutting to a straight line
- hand cutting a bevel edge
- cutting circles or radii

5. Objectives concerned with the acquisition of an understanding of the practical application of basic electrical principles.

The trainee should have an understanding of basic electrical principles, and safe electrical practices, and should be capable of:

- identifying cables (colour coding)
- selecting cables
- removing insulation

- soft soldering using electric iron
- terminating cables (straight bend and ring)
- selecting protection devices
- planning simple wiring circuits
- wiring simple circuits
- testing circuits for continuity and insulation
- testing circuits using a 240 AC supply
- hacksawing
- deburring
- bending and threading steel conduit
- assembling simple conduit systems

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