Master of Philosophy Thesis

in

THE USE OF INDIVIDUALIZED LEARNING IN
A SYSTEMS APPROACH TO BENCHWORK SKILLS TRAINING
AT AN INSTITUTE OF TECHNOLOGY

Under the supervision

of

Professor L.R.B. Elton

Institute for Educational Technology
University of Surrey
Guildford, England

Surat Thaitrong
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ABSTRACT

This research started from the analysis of problems existing in the present metal benchwork practice course for the first year skilled worker students (age from 16-20 years old), at the King Mongkut's Institute of Technology, North Bangkok Campus, Thailand. The contents of the course were derived from the training specification which was formulated from the analysis of the present workshop exercise project. With the use of a systems approach the new training system was designed, consisting of four successive training stages. The main aims of the design were to minimize the teacher's load and at the same time to achieve students performing all workshop tasks for the teacher. Two methodologies were used; first, a systematic distribution of student tasks throughout the four training stages; second, the use of individualized learning.

Due to a number of limitations on the researcher, the new training system and learning materials were designed and prepared for use only in the first half of the semester, and the second half continued the traditional system.

Four different types of self-learning materials were designed particularly for each training stage, using the technique of pictorial narrative information, information mapping, and linear pictorial programmed quizzes. The network diagrams were used to organize contents of topics and exercises of the four stages.

A number of experiments were carried out in comparative studies of different learning methods in the first stage of the new training system, using students from two intact classes of the concrete construction trade. Students were mixed together and then divided into two equal groups. The comparative studies were between self-learning with study unit programmed texts of my design and lectures, and on commercial extracts between solutions given to the exercises and no solutions given to the exercises.

The new training system was implemented with the same two classes of students. The researcher supervised students from the apprentice scheme class, while two regular workshop teachers did the conventional scheme class.
Analysis of results of the training were carried out on both parts of workshop knowledge, i.e. benchwork theory and technical drawing, and workshop exercises. The former were analysed up to the end of the workshop practice course, while the latter to the end of the new training system.

In evaluating the new training system a series of criterion questions were formulated and all were expected to be answered positively and satisfactorily. The required answers were gathered from results and conclusions of many areas of student achievements, survey questionnaires of students' attitudes and preferences, and teacher interviews. Results on areas of weakness were tabulated and suggestions were made on improvements which could be carried out.
ACKNOWLEDGEMENTS

I must first express due gratitude to the many people who have contributed to this research and thesis. None however is more fitting than that due to Professor L.R.B. ELTON for his wealth of advice and constant encouragement.

Firstly I must thank those who helped me to carry out the experimental work in Thailand. They comprise: DR. SOMCHOB CHAIYAWES Vice Rector of the King Mongkut's Institute of Technology, North Bangkok Campus, MR. SAMREONG RASEMEVISAWA the Director and MR. BANLENG SORNNIL the Vice Director of the College of Industrial Technology, MR. CHEUN MENAK the head of the benchwork practice workshop and his assistants, and the 1979 first year skilled worker students of the CC and ACC classes, my 'obedient subjects', the first year skilled worker students who took part in two trial tests in technical drawing and benchwork and MR. WANCHAI CHAICHUMCHEON and other members of the teaching practice supervisory team for mechanical technology.

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# CONTENTS

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
</tr>
<tr>
<td>CONTENTS</td>
</tr>
<tr>
<td>CHAPTER ONE</td>
</tr>
<tr>
<td>1.1</td>
</tr>
<tr>
<td>1.2</td>
</tr>
<tr>
<td>1.3</td>
</tr>
<tr>
<td>1.4</td>
</tr>
<tr>
<td>CHAPTER TWO</td>
</tr>
<tr>
<td>Section 1</td>
</tr>
<tr>
<td>2.1</td>
</tr>
<tr>
<td>2.2</td>
</tr>
<tr>
<td>2.3</td>
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<tr>
<td>2.3.1</td>
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<tr>
<td>Section 2</td>
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<tr>
<td>CHAPTER THREE</td>
</tr>
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<td>3.1</td>
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<td>Section 1</td>
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<td>3.4.9</td>
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<tr>
<td>Section 2</td>
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<tr>
<td>3.5</td>
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<td>3.5.1</td>
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<td>3.5.2</td>
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<td>3.5.3</td>
</tr>
<tr>
<td>3.5.4</td>
</tr>
<tr>
<td>3.5.5</td>
</tr>
</tbody>
</table>
CHAPTER FOUR
EFFECTIVENESS OF TEACHING LEARNING METHOD, SKILL-PERFORMANCES, AND OTHER QUALITIES OF A PROGRAMMED TEXT.

4.1 Introduction 89
4.2 Evaluation 89

Section 1
4.3 Effectiveness of teaching-learning methods 90
  4.3.1 Experimental conditions 90
  4.3.2 Analysis 91
  4.3.3 Results 91
    a) Techniques in filing flat work 91
    b) Dial indicators 94
    c) Use of the chisel and chiselling 96
    d) Use of the saw and sawing 98
  4.3.4 Factors affecting test reliability 100
  4.3.5 Summary of findings 101

Section 2
4.4 Student performances on preliminary benchwork skills 102
  4.4.1 Overview 102
  4.4.2 Procedures and analysis 102
  4.4.3 Results 104
    a) Layout work 104
    b) Filing rough surfaces 105
    4.4.3.1 Discussion 105
    c) Sawing and chiselling 107
    4.4.3.2 Discussion 108
  4.4.4 Conclusion 110

Section 3
4.5 Other qualities of a programmed text 111
  4.5.1 Rationale 111
4.5.2 Instrumentations
4.5.3 Analysis
4.5.4 Results
4.5.5 Discussion

CHAPTER FIVE DEVELOPMENT OF SYSTEM : KNOWLEDGE

5.1 Overview
5.2 A general model of the learning system for workshop knowledge
5.3 Aims of research studies
5.4 Measuring instruments and tests
   a) Criterion test
   b) Achievement test on benchwork theory
   c) Metal trade principles, Part 1 test
   d) Metal trade principles, Part 2 test
   e) Technical drawing test
5.5 Analysis and results on the immediate achievement, the short-term retention, and the medium-term retention of students, on study programmed texts
5.5.1 Models and analysis of students' knowledge on study programmed texts and factors affecting their learning
   a) The learning period
      (immediate achievement)
   b) The second period, or the short-term retention
   c) The medium-term retention
5.5.2 Results on students' knowledge of study programmed texts
   a) The learning period
      (immediate achievement)
   b) The short-term retention
   c) The medium-term retention
   d) Factors affecting student learning on study unit topics
      i) Relationship between retention test (1) and retention test (2)
      ii) Relationship between the retention test (1) and classroom teaching, benchwork theory and technical drawing
5.6 Development of students' knowledge on benchwork theory and factors affecting their learning
   a) Development of student learning at the study unit stage 142
   b) Development of student learning at the end of the consolidating unit stage 144
   c) Development of student knowledge at the end of the exercise unit stage 145
   d) Development of student knowledge at the end of the course 147

5.7 Results on changes in student knowledge on benchwork theory 149
   1) Knowledge gained on benchwork theory at the end of the study unit stage 152
   2) Knowledge gained on the benchwork theory at the end of the consolidating unit stage 154
   3) Knowledge gained on benchwork theory at the end of the exercise unit stage 157
   4) Lost knowledge of benchwork theory at the end of the course 159

5.8 Development of students' knowledge of technical drawing 164

5.9 Summary of results 168

CHAPTER SIX DEVELOPMENT OF SYSTEM : SKILLS 171

6.1 Overview 171
6.2 Aims of the evaluation 172
6.3 Design of the study 173
6.4 Measurements 173
   6.4.1 The pre-study unit stage test 174
   6.4.2 The post-study unit stage test 175
   6.4.3 The post-exercise unit stage test 176
6.5 Other factors 176
6.6 Analysis of finished work 177
Section 1 Development of skills 179
6.7 Analysis 179
6.8 Results 180
   6.8.1 Initial stage 180
6.8.2 Early stage 182
6.8.3 Later stage 186
6.9 Conclusions 191

Section 2 Differences between CC and ACC students on workshop activities 192
6.10 Preconditions 192
6.11 Analysis 193
6.12 Results 193
   6.12.1 Product outcomes 193
   6.12.2 Production times 199
   6.12.3 Grading finished work 200
   6.12.4 Planning operation sheets 206
6.13 Conclusions on differences between CC and ACC students on workshop training 207

Section 3 Factors affecting workshop skills and activities 208
6.14 A system diagram 208
   6.14.1 Instructional and training 209
   6.14.2 Immediate environment 210
   6.14.3 Physical characteristics 210
6.15 Analysis 211
6.16 Results 212
   6.16.1 Contribution of workshop knowledge to planning 212
   6.16.2 Relationship between achievement on production work and planning, technical drawing and benchwork theory 215
   6.16.3 Relationship between achievement on production work and production time 216
   6.16.4 Relationship between the achievement on production work and successive training and tests 217
6.17 A summary of results of factors affecting workshop skills and activities 224
CHAPTER SEVEN DEVELOPMENT OF SYSTEM: ATTITUDES

7.1 Overview

7.2 Working conditions under the traditional training system

7.3 Working conditions under the new training system

7.4 Orientation to the new workshop training system

7.5 Areas of the study on student attitudes and perceptions towards the new and the traditional training systems

7.5.1 Rationale for the study into student attitudes at the pre-system stage

7.5.2 Rationale for the study of students attitudes at the post-study unit stage

7.5.3 Rationale for the study into student perceptions towards the activities and components of the new training system

7.5.4 Rationale for the study into student preferences as regards the new and the traditional training systems.

7.5.5 Rationale for the study of teacher involvement in student activities in the new and the traditional training system

7.6 Instrumentation and implementation

7.6.1 The survey questionnaire into student attitudes at pre-system stage

7.6.2 The survey questionnaire into student attitudes at the end of the study unit stage

7.6.3 The survey questionnaire into student perceptions of the activities and components of the new training system

7.6.4 The survey questionnaire into student attitudes towards the new and the traditional training systems
7.6.5 The survey questionnaire about teacher involvement in the new and the traditional training systems 239
7.7 Analysis of results 240
7.8 Results and discussion 241
  7.8.1 Results of student attitudes at the pre-system stage 241
  7.8.2 Results of student attitudes at the end of the study unit stage 251
  7.8.3 Results of student perceptions of activities and components of the new training system 258
  7.8.4 Results of student attitudes towards the new and the traditional training systems 273
7.9 Summary of findings 308

CHAPTER EIGHT THE SYSTEM AS A WHOLE 311
  8.1 Overview 311
  8.2 Aims of the evaluation and decision criteria 311
  8.3 Results of teacher interviews 314
  8.4 Evaluation of outcomes of the study unit stage 320
  8.5 Evaluation of outcomes of the consolidating unit stage 326
    8.5.1 Aims of the evaluation and results 326
  8.6 Achievements of students on workshop knowledge 329
    8.6.1 Aims of the evaluation 329
    8.6.2 Results 329
    8.6.3 Conclusions and suggestions 335
  8.7 The overall conclusion of the evaluation on the new training system 336

CHAPTER NINE CONCLUSION AND FURTHER OUTLOOK 341
  9.1 Conclusion 341
  9.2 Further outlook 345

BIBLIOGRAPHY 347

XII
A1 Components of the present workshop exercise project: a small vice
A2 An analysis of the process involved for each part of the present workshop exercise project: a production of a small vice
A3 An example of analysis of production processes
A4 An example of scoring and deciding workshop training needs
A5 Training goals of the workshop training course
A6 Training specification of the benchwork practice course
A7 Terminal objectives of the study unit stage
A8 Terminal objectives of the practice unit stage
A9 Terminal objectives of the consolidating unit stage
A10 Terminal objectives of the exercise unit stage
A11 Network diagrams of the study unit, practice unit, consolidating unit, and exercise unit stages
A12 Timetable for workshop training and classroom teaching on Metal Trade Principles (1)
B1 An example of a complete programmed text on the techniques in filing flat work
B2 An example of the practice unit programmed workshop exercise leaflet
B3 An example of the programmed quizzes used in the consolidating unit stage
B4 An example of the programmed workshop exercise leaflet used in the exercise unit stage
B5 An example of objectives on the use of the saw
B6 An example of objectives, exercises and test on the use of the chisel
| B7 | An example of the practice exercise in sawing and chiselling given after the completion of theoretical study of a study unit programmed text | 401 |
| B8 | An example of the observation sheet used on sawing chiselling during the first trial of students in the study unit stage | 401 |
| B9 | An example of practical work on layout work | 402 |
| B10 | An example of the solution sheet given to exercise 3 on layout work | 402 |
| B11 | An example of a lesson plan used for one of the author's lesson | 403 |
| C1 | Table of specification for benchwork knowledge test | 404 |
| C2 | Table of specification for technical drawing test | 405 |
| C3 | The sample of benchwork theory test used for both research subjects (CC and ACC students) and the first semester first year skilled worker students | 406 |
| C4 | The sample of the test of technical drawing | 412 |
| C5 | The sample of post-tests of 11 study unit programmed texts | 414 |
| C6 | An example of the basic workshop skill test, administered to the ACC students at the pre-system stage | 419 |
| C7 | The workshop test sheet used on the post-study unit stage | 420 |
| C8 | An example of the workshop test sheet on the post-exercise unit stage | 421 |
| C9 | An example of the assessment form for grading student performance and the work done in the practice and exercise unit stages | 422 |
C10 The workshop observation form which was proposed for using in the training
C11 An example of the observation checklists used in testing basic workshop skills of the ACC students at the pre-system stage
C12 An example of the completed assessment sheet used in the study unit stage post-test
C13 An example of the observation sheet used at the end of the exercise unit stage test
C14 An example of the grading sheet used in the post-exercise unit stage test

D1 Statistical details of the analysis of covariance as used in adjusting the mean post-test scores in Dial Indicator lesson
D2(a) Kolmogorov-Smirnov one sample test
D2(b) Kolmogorov-Smirnov two sample test

E1 Test scores of CC and ACC students on technical drawing and benchwork theory
E2 Student response plot on techniques in filing flat work
E3 Student response plot in technical drawing, at the end of the training course
E4 Response distribution in student attitudes at the pre-system stage
E5(a) Response distribution in student attitudes towards the principles of the individualized learning
E5(b) Response distribution in student perceptions into the structure of the study unit programmed texts
E6 Response distribution in student perceptions to activities and components of the new training system
| E7 | Response distribution in student perceptions to comparative teacher roles and to equivalent programmed aids in the new training system | 444 |
| E8 | Response distribution of student preference in activities, events and conditions in the new and the traditional training systems | 446 |
| E9 | Response distribution in the degree of teacher's involvement in student activities in the new training system | 449 |
| E10 | Response distribution in the degree of teacher's involvement in student activities in the traditional training system | 452 |
1.1 BACKGROUND INFORMATION

My research was conducted at the College of Industrial Technology, King Mongkut's Institute of Technology, North Bangkok Campus, Thailand. The research concerned the teaching of Metal benchwork skills on a training course at the skilled worker level. Students who entered into this course were school leavers either from general secondary schools or comprehensive secondary schools, and were aged between 16 to 20 years old. I shall begin by describing the existing situation as I found it.

There are 8 different trades in the skilled worker level, categorized into 3 major divisions: mechanical, electrical, and civil construction. At present (1979) the Institute has in operation two different training programmes at this level - conventional and apprenticeship. Diagram 1.1 shows the official number of students in each trade classified by trade division and training programme. Notice that there was no mechanical drafting trade (DG) in the apprenticeship programme.

<table>
<thead>
<tr>
<th>Division Programme</th>
<th>Mechanical</th>
<th>Electrical</th>
<th>Civil Construction</th>
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<td>EE 20</td>
<td>CC 20</td>
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<tr>
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<td>DG 20</td>
<td>EM 20</td>
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<td>AAM 20</td>
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<td></td>
<td>AMM 20</td>
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Legend: AM = Auto mechanic
DG = Mechanical drafting
IP = Industrial Plumbing
MM = Machine mechanic
EE = Electro mechanic
EM = Electronic mechanic
CC = Civil construction
MW = Machine woodworking mechanic

Diagram 1.1 Numbers of students in different trades at the skilled worker level, at King Mongkut's Institute of Technology, North Bangkok Campus in 1979.
There is one distinguishing difference between the conventional and the apprenticeship training programme. The former has each week two days of classes and three days of workshop practice whilst the latter has two days classes and four days workshop practice. In the first year at the Institute students of both programmes study and practice the same courses, except for a small number of directly trade-specific subjects.

The metal benchwork practice course was formerly allocated to all first year skilled worker students for two semesters. Until recently some trades replaced this course with practice in their specific trades and this meant a slight change in timetable. Students from the concrete construction trade entered this course in the second semester while others entered for either or both the first and the second semesters.

One project in the practice exercises - the production of a small vice - had to be completed in the second semester together with other additional exercises. Because many of the workshop teachers concerned valued it very much, this project was implemented even for students who studied this course for only one semester. Students in these circumstances, of course, could hardly complete this project within the semester but they were allowed to continue with it after the final examination.

Two technical subjects, Mechanical perception into technical drawing and Basic metal trade principle, were regarded as closely related to the knowledge required in the workshop practice of the metal benchwork practice course. But since they were taught in normal classrooms for two periods a week, and each topic had accordingly to proceed to a certain logical order; they were actually not ready for use in time and thus followed rather than leading workshop practice. Thus, workshop teachers had to provide special sessions for students in the workshop where noise from machines and production activities were intensively strong. Lessons

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1. One academic year has 2 semesters, lasting for 16 weeks each.
2. As identified by the task analysis discussed in Chapter 3.
given were more or less dependent upon teacher preferences and dedication rather than careful, systematic planning. Neither learning objectives nor post test were provided or administered.

Students for long had been experiencing only limited teaching methods, usually only lectures, in their previous schooling. Their learning skills were also limited due to shortage of good publications and other information resources, eg. programmed instruction, films, television, etc. They were almost entirely dependent on teachers who also had to some degree difficulty in understanding the commonly available books in foreign languages, i.e. in German or English.

One major barrier to students' learning and development might be due to school regulations and discipline. Both at home and at school students generally refrained from arguing or criticising the elderly, parents or teachers because those people were 'born before'. Students would obey and comply with given instruction with respect and appreciation. In the Institute only the first year skilled worker students were not allowed to arrive late, wear coloured T-shirts, or have beards or moustaches, under pain of punishment and humiliation. Students had to work exclusively within working hours; no special working during breaks or in overtime was allowed.

Many workshop teachers, as elsewhere in other technical colleges, had overloaded timetables, due to teaching duties in both day and evening classes. Some workshop teachers were also studying themselves to upgrade their qualifications.

An autocratic teaching style was generally used in workshop training by which workshop teachers played dominant roles in teaching, sequencing topics and practice exercises, solving students' working problems and grading students' work. In most circumstances fast working students would gain more benefits from the explanations and demonstrations of the workshop. This was because the teachers had to provide further knowledge to the faster students when they came to any new exercise. However, every student had his own book of exercises which contained information like drawings, operation sequence, the tools, equipment to be used and some working illustrations.

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1. Cheun Menak and Siriwan Rakganngan, 1977, 'Metal work practice exercises'.
The grades awarded to students at the end of the course were subject to the particular teacher in charge of each class of students. Neither theoretical nor practical tests were administered during the course. Part of the work produced by the student was used as a grading criteria.

Grading criteria were categorized into abilities, responsibilities and disciplines.

Despite the fact that the present training system had been in operation for eight years, no evaluation had been carried out, into its effort, effectiveness and efficiency.

1.2 AIMS OF THE RESEARCH

Even though, there were no concrete evidences available to justify some deficiencies existing in the present training of the metal benchwork practice course, as described above. The following problems were recognised, and possible solutions as well as methods were suggested, based on my personal impression and understanding.

Some essential problems existing in the metal benchwork practice course together with solutions and methods for them are given in the problem analysis shown in table 1.1.

The aims of my research study were established in accordance with the problem analysis, as follows:

1. To devise a new workshop training system which was capable of solving some of the problems mentioned above by using a systems approach and an individualized system of instruction.

2. To design and construct some learning materials, aids, and other devices necessary for students to acquire the required workshop knowledge and carry out the work in the present practice exercises.

3. To compare the effectiveness and efficiency of different learning and teaching methods, based on topics and materials produced for the new workshop training system.

4. To determine the development of student knowledge and skills over successive stages of the new workshop training system.

5. To survey student attitudes towards activities and components appearing in the present and the new workshop training system.
6. To compare the degree of teacher involvement in the students' work in the present and the new workshop training system.

Table 1.1  Problem analysis on the metal benchwork practice course.

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<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
<th>Method</th>
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<td>Students inexperienced in study skills</td>
<td>Introduce some new learning methods</td>
<td>Programmed instruction, learning package, group discussion, tutorial</td>
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<td>Poor classroom conditions in the workshop</td>
<td>Improve the existing classroom, look for another room, establish classroom free learning system</td>
<td>Individualized system of instruction</td>
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<tr>
<td>Project in the present course too lengthy</td>
<td>Allow more time to complete e.g. working in overtime or during breaks</td>
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<tr>
<td>Overloaded timetable for workshop teachers</td>
<td>Phaseout teacher, engagement, increase student responsibility</td>
<td>Systems approach and work distribution</td>
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<tr>
<td>Timetable unmatched between classroom teaching and workshop practice</td>
<td>Build in on information stage into the system</td>
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<td>Lack of systematic training and task enrichment</td>
<td>Provide successive learning and training stages</td>
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<tr>
<td>Lack of systematic guidance and supervision</td>
<td>Provide continuous assessment, self-evaluation and joint activities between students and teachers</td>
<td>Continuous assessment</td>
</tr>
<tr>
<td>Inefficient teaching methods</td>
<td>Provide workshop seminar, short inservice training course for teachers</td>
<td>Consult administrators</td>
</tr>
<tr>
<td>Over strict rules and regulations</td>
<td>Reconsider rules and regulations, eliminate unnecessary regimentation</td>
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1.3 OUTCOME OF THE RESEARCH

I expected as the outcome of my research the following:

1. Provision of ideas on design and construction of learning materials, aids and measuring instruments for both workshop knowledge and skills.
2. Provision of ideas on design and use of both a systems approach and individualised systems of instruction in learning and training.
3. Encouragement to teachers and administrators in the use of a variety of teaching and learning methods.
4. Provision of descriptive information for further improvement, development and establishment of standards for student learning and training.
5. Provision of descriptive information for the improvement and development of a strategy and tactics in the management of student learning and training.

1.4 LIMITATIONS OF THE RESEARCH

My research study had the following limitations:

1. The subjects would be taken intact from classes of the first year skilled worker level who attended the metal benchwork practice course in the second semester.
2. The research assistants would be regular workshop teachers in charge of existing classes.
3. The scope of workshop knowledge was determined by the task analysis and design of my workshop training system.
4. All learning materials, aids and devices used in the research were prototypes.
5. Any differences between the features of my workshop training system and the present workshop rules and regulations could only be overcome by negotiations and compromise with administrators in charge.
6. The implementation of my workshop training system and learning materials would be limited to only the first half of the semester and the second half the present training system.

7. The tests and measuring instruments used were based on content validity, classical reliability and practicability.
2.1 OVERVIEW

This chapter contains two main sections, one dealing with individualized instructions, the other with factors in skill learning.

Part one presents a wide range of concepts, ideas, and principles of individualized learning, including individual differences. A number of drawbacks in traditional teaching and training in respect to skill training are presented, and there follows a rationale and some approaches to individualized instruction. In the last section the author presents his view and some possible approaches to individualized skill training within the current constraints of curriculum and administration at the Institute.

In part two are presented nearly all the aspects of skill learning considered to be directly relevant to the design and construction of the skill training system. The author presents first the descriptive model of skill learning stages and then follows massed-distributed practice, whole-part methods of training, knowledge of results, and transfer of skills. Other factors concerned with the acquisition of skills are presented later in Chapter 3.

SECTION 1: INDIVIDUALIZED INSTRUCTION

2.2 WHAT IS INDIVIDUALIZED INSTRUCTION?

In Thailand teachers and students are very well familiar with traditional methods of lecturing. Individualized instruction is quite new for them.

Individualized instruction, according to many American writers, is a programme of instruction which imparts knowledge and skills with respect to specific well-defined goals that fits individual needs and interests. For example, Glaser (1966) states, 'By individualization of instruction I mean the adaptation of instructional procedures to the requirements of the individual learner'; Wittich and Schuller (1973) state, 'Individualized instruction consists of learning experiences specially designed for individual students on the basis of diagnostic procedures employed to determine individual interests and needs; once
established, these learning experiences are largely self-directed, self-administered, and, within broad limits, self-scheduled according to the interests and experience of the learner.'

It is important at this stage to introduce the term 'independent' in the context of the term 'individualized'. Some writers have regarded them as synonymous, e.g. Green (1976) whose rationale for independent learning in science is based on the advantages of individualization. However, other writers have differentiated between individualized and independent study. For example, Dressel and Thompson (1973) define independent study as 'the student's self-directed pursuit of academic competence in as autonomous a manner as he is able to exercise at any particular time.' Percey and Ramsden (1980) mention, 'Individualization may foster the motivation for independent work and, if properly conducted, will merge into independent study as responsibility for direction is transferred from teacher to student. But independent and individualized study are not equivalent. They may or may not be associated together.'

The distinction between independent and individualized study as presented in 'Individualized learning Unit 1, Dundee College of Education, 1979, p.5.' Manwaring has put it into two continua: as demonstrated in the diagram.

Thus, student project work may be individually selected and worked out entirely by the student, but he will be very much dependent on teacher's supervision and assessment. C. R. Wilson (1979) follows this concept and makes the following definition:

'Independent learning as that which the student learns with less direct control by a teacher than in the traditional lesson/

lecture situation; individualized learning as that in which the instruction is tailored to the individual student's needs more than in the traditional situation.

2.3 TYPES OF INDIVIDUALIZED INSTRUCTION

Following the Wittich and Schuller definition, individualized instruction programmes are orientated towards individual rather than towards group or class techniques. Theoretically programme designing has taken all kinds of individual differences (e.g. personality traits, cognitive abilities, curiosity traits, etc.) into account, but in actual practice it is dependent on how a specific programme is designed and administered. Thus, various types of individualized instruction programme emerge.

Many writers have identified types of individualized programmes differently. Manwaring (Individualized learning Unit 2, 1978) mentions three types: the Keller Plan or P.S.I. (Personalized System of Instruction), Audio-Tutorial, and Distance Learning. Gange' and Briggs (1979) present five different types, Independent Study Plans, Self-Directed Study, Learner-Centred Programmes, Self-Pacing, and Student-Determined Instruction. Edling (1970) identifies four major types, based primarily on who determines what should be the objectives, the methods, materials and media to be used in achieving them. Thus he lists Individually Prescribed Instruction, Self-Directed Instruction, Personalized System of Instruction (PSI) and Independent Study.

But it seems that there is no common criterion among these writers in categorizing types of individualized programmes. This does not matter here. The emphasis at this stage is rather to conceptualize general procedures of some individualized programmes. I would prefer in this occasion to follow Edling's classification.

2.3.1. INDIVIDUAL PRESCRIBED INSTRUCTION

This is characterized by all students having required to achieve a certain proficiency in some specified abilities such as reading, mathematics, and to go through a specified series of materials and
exercises to attain the desired levels of performance. The principal individualization in this instance is that the student works at his own pace. Behavioural objectives are clearly defined, a well-defined systems of materials and methods of instruction have been developed based on careful diagnosis of individual students and their learning needs. In placing students at the proper level in each subject area and in prescribing an individual learning sequence for each student, placement tests, pre-tests, skill book-tests, or curriculum-embedded tests are used.

2.3.2 SELF-DIRECTED INSTRUCTION

In self-directed programmes, the teacher may supply a list of objectives which define the test performance required to receive credit for the course; the teacher may also supply a list of reading or other resources available, but the student is not required to use them. The student has the freedom to determine how he will study and when he will seek assistance.

2.3.3 PERSONALIZED SYSTEM OF INSTRUCTION (PSI)

This system allows the student to choose objectives that appeal to his interest from a sizable list of possible objectives. Once these are selected, the student enters into a contract incorporating specific objectives, resources, and instructional procedures. He fulfills the contract by completing a prescribed test or other evaluation procedure.

Here the 'contract' has a special meaning; it is an agreement that a student enters into with his teacher specifying what he will undertake and what he will achieve at his own pace in furthering some specific aspect of his own learning.

2.3.4 INDEPENDENT STUDY

This type of individualized instruction provides the greatest degree of freedom in that students pick both their objectives and their methods of study. There is, however, agreement between the student and teacher but only on the most general level of stated objectives which indicate the purpose of studying. A course outline
may or may not be provided. The task may be described at the course level in such an expression as 'preparing for an examination in differential calculus'.

From a consideration of these various types of individualized instruction programmes can be summarized four main aspects (i.e. objectives, learning materials, sequence of learning, and learning methods) by which the degrees of individualization can be immediately differentiated, as shown in Table 2.1.

<table>
<thead>
<tr>
<th>Types of Individualized Instruction Programmes</th>
<th>Individually Prescribed</th>
<th>Self-Directed</th>
<th>Personalised System</th>
<th>Independent Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives</td>
<td>Fixed</td>
<td>Fixed</td>
<td>Self-selection</td>
<td>Self-determination</td>
</tr>
<tr>
<td>Learning materials</td>
<td>Pre-programmed</td>
<td>Self-selection</td>
<td>Pre-selected</td>
<td>Self-determination</td>
</tr>
<tr>
<td>Sequence of learning</td>
<td>Pre-selected</td>
<td>Self-determination</td>
<td>Pre-determined</td>
<td>Self-determination</td>
</tr>
<tr>
<td>Learning method</td>
<td>Self-determination</td>
<td>Self-determination</td>
<td>Self-determination</td>
<td>Self-determination</td>
</tr>
</tbody>
</table>

Table 2.1 Degrees of individualization of four types of individualized instruction programmes.
2.4 FEATURES OF INDIVIDUALIZED INSTRUCTION

To further understanding of individualized instruction, it is useful to consider some general features. Manwaring presents some features of individualized learning in 'Aspects of Educational Technology' Volume X, 1976, and Individualized Learning, Unit 1, 1979. The following are taken from the latter work and deal with ten general features.

1. **Availability** The material to be learned by the student is presented in individualized study units and so is more readily available than say, a lecture course. The student can study at any time, and often in a place that suits him.

2. **Self-paced** Individualized learning is self-paced. The student spends as much or as little time as he needs on each study unit, and takes as long as he likes to answer questions.

3. **Objectives** Individual study units frequently contain a detailed list of objectives that students can use as a checklist of items to be learned.

4. **Mastery** The student aims to master the objectives and he knows in advance the level of proficiency he has to achieve. Mastery is the accepted standard for the whole class. The approach is criterion-referenced rather than norm-referenced. The differences between students are in the time taken not in the final standard.

5. **Interaction** One obvious feature of individualized learning is that the teacher is often not with the student while he is receiving instruction. Active, relevant involvement of the student facilitates learning and maintains concentration. Activities can include multiple choice items, short essays, and practical exercises as appropriate. Usually answers or comments are available so that the student receives feedback on his performance and can judge his own progress.
6. **Tutor Help** Individualized learning systems do not expect students to work entirely alone and unaided. Help from tutors is usually available as and when it is needed.

7. **Tests as learning situation** Regular tests are a part of most individualized learning systems but they are designed and used as part of the teaching/learning process, rather than a way of grading the students. Each test is based on the objectives of the unit covered.

8. **Multi-media** A variety of different media are often incorporated into the learning units. These include slides or filmstrips, audio tapes, models and experiments, video tapes and a study guide. The characteristics of the different media can be used to help communication with the student.

9. **Choice of Method** Different students prefer to learn in different ways. Individualized learning can be an option for students who do not enjoy mass lectures, or, with individualized learning it is possible to offer the student a variety of learning methods. They may even choose their own methods of working through a unit, and different people may use it in different ways. Some may skim the whole unit and then study it in detail, some may go through and try to answer all the questions and carry out all the activities and tests before reading the instruction part of the unit. In other words, students often develop an individual learning strategy which suits them.

10. **Choice of Sequence** In some subjects, the order of units is determined by the logical structure of the topic. But there are times when the sequence of related items does not matter. On such occasions the student can select his own sequence of instruction depending on his own interests. It may be possible to allow a large number of routes through a series of learning units. The whole course might include remedial units, enrichment units and a series of equivalent options, although some core material may be compulsory.
Not all these features are covered in every individualized instruction programme, and many other individualized instruction programmes have other features which are not mentioned here.

Immediate questions on these features of individualized learning are:

1. How are these features and others derived?
2. What are the main aims of the individualized instruction programmes?
3. What are the advantages of the individualized instruction over the traditional lecture method?
4. How does individualized instruction suit workshop skill training.

All these aspects will be discussed in the following sequence, except 1. which is discussed in the next chapter. But they will be better understood if the topic 'individual differences' is discussed first of all.

2.5 INDIVIDUAL DIFFERENCES

One factor which has a bearing upon a number of students that can successfully be instructed in a single class is the spread of learning capacity among the members of the class. Individuals are capable of learning to a greater or lesser degree. Some individuals can learn a given skill or gain a given amount of knowledge more rapidly and with greater apparent ease than others. This is one aspect of 'individual differences'.

Individuals differ in many aspects such as knowledge, ability, personality, interest, age, sex and so on. These differences within and among individuals affect their style and capability in learning and training. Fry (1970) has distinguished four basic types of individual differences - personality, cognitive, inquiry, and sequence variables. I now present four variables which relate learning and instruction to individual differences.

2.5.1 PERSONALITY VARIABLES

It is recognizable that personality traits have an influence on how students react to various kinds of instruction. Indeed, many
research studies support this contention. Wittich and Schuler (1973) give one example: Students who are flexible in their thinking and who are able to cope with ambiguity and inconsistency seem best able to profit from the give-and-take of class discussion and/or problem-solving situations. On the other hand, students who seek definite, concrete, ordered, and consistent patterns of thought and who see themselves in more or less stereotyped ways tend to be more comfortable and content in more highly teacher-centred and specifically directed activities.

Learning styles of students seem to correlate rather closely with personality characteristics. Doty and Doty (1964:55) state that students having a strong interest in social acceptance and a corresponding need for it have been found to perform poorly with programmed instruction, while students who appear to be more withdrawn, less self-reliant, and more test-anxious perform successfully with it.

Another study shows that students tend to react quite differently, on the one hand to content which is governed by logical and inherently 'meaningful' rules and on the other, to content that is governed by 'arbitrary' rules. The difference in reactions correlates highly with whether the students are extrovert or introvert, high or low on test anxiety, and high or low on logical and socialaesthetic interests (Tallmadge and Shearer, 1969:60). A study of a group of 16-year-olds confirms the fact that extroverts seem to learn best with unstructured material and situations such as the 'discovery method', whereas introvert-type students seem to learn best with structured and 'prompted' learning situations (Leith, 1970:1.2)

2.5.2 COGNITIVE VARIABLES

Cognitive variables are those dealing with knowledge, preception, and understanding. These variables are mostly related to the traditional objectives of education. There are contradictory results on these studies. For example, the correlation between the results of general ability tests such as the Intelligence Quotient test and each individual's learning performance has generally been negligible (Carver and DuBois, 1967 : 4.3). On the other hand, when specifically relevant skills such as adding, subtracting, or following directions are studied, the correlation between these abilities and performance is
clearly positive (Gange'and Paradise, 1961, 75.218)

Wittich and Schuler point out that these findings strongly suggest the importance of careful and relevant diagnostic procedures as a preliminary to designing Individualized Instruction. Davis, Marzocco and Denny (1970:61) investigated the interaction between individual differences and several methods of presenting programmed instructions they made a significant discovery. This was that of two specific sources of individual differences, prior learning and general ability, the former appears far more useful in determining the best instructional method to be employed for a given student. These researchers join the psychologist Robert Gange'in viewing prior conditioning, transfer, and 'learning steps as accounting for most individual differences in cognitive learning (Gange', 1962:69)

2.5.3. INQUIRY VARIABLES

Differences among individuals in curiosity traits have received increasing attention in recent years. Wittich and Schuller stated, as educators have undertaken to open up the locked-step, teacher dominated patterns of classroom instruction by means of flexible scheduling, team teaching, the 'discovery method', and differentiated staffing.

For example, Lee Shulman and his associates studied the inquiry process among teachers in training a situation which, though simulated, was sufficiently realistic to achieve a fairly high degree of emotional involvement. They discovered significant and important differences between effective and ineffective 'inquirers' (Shulman, Loupe and Piper, 1968:5 - 0597)

In pursuing the study, they developed a battery of some 17 tests; they found that five of these proved to be good predictors of inquiry performance. Their findings characterized the effective inquirer as 'high in associational frequency; - high in cognitive complexity, preferring the ambiguous, asymmetrical, and the unexpected to the regular, articulated, and predictable ; liberal in political values, willing to risk on a test of logical thinking; high in verbal problem solving; and low in expressed test-anxiety'. (Shulman, 1965: 73)
A considerable number of studies have been done on programmed instruction materials to assess the relative effect on achievement of random versus logical sequences. Though it might seem likely that logical steps or sequences would be essential to effective learning with programmed instruction, actually this appears not to be the case with most of the material that was considered (Niedermeyer, 1968:16). On the other hand, a more recent study shows no differences between random and logical sequences nor between high and low ability students on higher order, more complex, problem-solving programmed instruction sequences (Brown, 1970:61). In consequence, at last Leith (1970) has suggested that randomly arranged learning experiences of other types may also be more beneficial than systematically arranged instruction.

From a frame of reference similar to Shulman's, John Fry undertook to test the hypothesis that inquisitive individuals can control their own learning or instructional strategies and thereby learn more and be more satisfied, than when they used conventional means. He ascertained that individual differences do appear to exist among individuals within this specific dimension of student control of instructional situations. He found further that highly inquisitive students who are also high in aptitudes can advantageously control their own learning. However, students with less aptitude, even though highly inquisitive, appear to do better when the sequencing and control of the learning experience are in the hands of the instructor (Fry, 1970).

Fry also found that the random-sequence treatment was highly effective with his high-aptitude, high-inquiry students. Finally, his results indicate clearly that in addition to prior learning experiences and basic abilities - the predominant sources of individual differences - there are distinctive differences in learning styles which must be taken in to account in designing instructional strategies.

The individual differences presented above indicate how individuals differ in their thinking on, interpretation, performance, and style of learning with regard to the contents, structures and sequences of given learning materials. This is just another aspect
of individuality in addition to Maslow's human needs and Herzber's motivation—hygiene theories discussed in Chapter 3, section 1.3.2 and 1.3.3., of how individuals react to other human beings, and the environment.

2.6 DRAWBACKS TO TRADITIONAL TEACHING AND TRAINING

By reference to aspects of individual differences, it can be recognized that no two persons are alike. For this reason traditional methods of teaching/training—lectures and an autocratic style of teaching—are criticized today.

Leighbody and Kidd (1966) state that 'When the teacher receives a class into his workshop or classroom for instruction, he is confronted, then, with a number of learners who cannot be considered exactly or even approximately identical with respect to their response to his teaching methods. The fact that they are all in the same school year or even the fact that they have all passed the same subjects before being assigned to this class does not assure the absence of a wide range of learning differences in the class.... The greater the difference between the slowest and the fastest learner in the class, the greater the need for special consideration of individuals, and generally speaking, the more difficult the task of carrying on profitable instruction'. (p.156-7)

In traditional workshop training the teacher is the supreme commander over his students. He usually manages his workshop in autocratic rather than co-operative style. Yet the results of student training turns out to be more favourable to the latter situation.

Nölker and Schoenfeldt (1980) follow Klafki on the comparison between autocratic and co-operative styles of training. The autocratic manager/instructor is characterized by a high degree of authoritarianism, and control over and disdain for those under his charge. The co-operative manager/instructor is distinguished by virtue of 'warm hearted' social contacts and 'concern and encouragement' for those under his charge. In summary autocratic managers in factories, workshops and laboratories '....achieve lower rates of production and a significantly higher degree of spoiled work, complaints and registrations than do managers who are co-operatively oriented'. (p.21). Of course these finding throw light on the role of the manager's
personality and his skill in organizing the work effectively.

It is not only that teaching/training methods may obstruct individual development, but also the present system of education as a whole. Arther W. Combs views much of the curriculum of present schools as: 'Preoccupation with right answers; insistence upon conformity; cookbook approaches to learning; overconcern for rules and regulations; preoccupation with materials and things instead of people; the solitary approach to learning; the delusion that mistakes are sinful; emphasis on memory rather than learning; emphasis on grades rather than understanding and content details rather than principles'. (p.31. Howes, 1970).

To overcome these drawbacks of the present education system in respect to individual development, the system of individualization of instruction is a most sensible solution.

2.7 RATIONALE FOR INDIVIDUALIZED INSTRUCTION

It is acceptable that there are many drawbacks in the traditional system of instruction as presented above. In Thailand, the situation is arguably much worse than many experts might have thought, especially up-country. There schools and colleges have insufficient budget allowances, shortage of personnel and a scarcity of other resources. They are in need of rescue operations rather than innovations. However, many colleges and institutes in towns and the capital are in better positions and more adaptable to new innovations and improvement.

Two classical alternatives to the problems in traditional instruction are: reduction of student teacher ratio and ability grouping. But, they are somehow not really suitable and are also inefficient, Wittich and Schuller make the following comments on the student teacher ratio solution. 'Much of the argument for improvement of our schools fall back on the traditional belief that lower pupil-teacher ratios would somehow solve the problem. This position is based on the theoretical assumption that with fewer pupils the teacher could somehow give sufficient individual attention to each of his pupils to correct whatever deficiencies may exist by reason of inadequate prior learning, inadequate economic and cultural backgrounds, or curriculums inadequate to the needs of today's students. The assumption is naive on two counts. First, the problem is not all
that simple; second, no teacher can deal adequately with the myriad individual; personal, social, and academic needs of even 20 or 25 pupils'. (1973, p.603)

Leighbody and Kidd on the other hand comment on ability grouping thus: 'In many schools, an attempt is made by the school administration to narrow the range of learning differences among members of any single class by placing in one class, pupils with approximately the same learning capacity, so far as it is possible to do so. There are practical difficulties which prevent this plan from being entirely successful. For one thing, the only instrument available for determining the comparative learning rates of individual pupils are imperfect. The classification is usually made by giving all pupils a general intelligence test or perhaps a mechanical aptitude test, and grouping in classes those within certain ranges, based on the results of the tests. The tests themselves are not likely to measure learning capacities or rates very accurately, particularly in shop subjects. Then, too, unless there is a very large number of pupils to be divided into many classes, the differences between those who must be assigned to a single class are still fairly great. From the point of view of efficiency of teaching, this method is partially successful. Some teachers object to this method on the grounds that it is an artificial arrangement, since in real life the more capable and less capable live and work together. They claim, further, that some stigma is attached to the pupil who is assigned to a 'slow group'. (1966, p.157)

Solutions to individual differences now directed towards individualized instruction as evidenced by ideas and rationale from many writers.

B. F. Skinner put his idea towards providing for individual differences in programmed instruction. He regards accommodating them as critical to increasing the effectiveness of current educational programmes. He states, 'Failure to provide for individual differences among students is perhaps the greatest single source of inefficiency in education'. (1968, p.242).

Robert Glaser points out the superior results from individualized instruction and also the lack of such results with traditional methods. He states, 'First, a system of individualized instruction nurtures independent learning and, as a result, has the potential for producing individuals who are self-resourceful and self-appraising
leaders. Resourceful individuals of this kind cannot be produced in any significant numbers by our traditional educational environment in which the primary burden of initiating and maintaining learning is the job of the teacher rather than the job of the learner. At the very least, should be a shared endeavour'. (1970, pp.129-130).

Bernice J. Wolfson gives another reason to support the need to individualize instruction: '...the purposes of education, as least as I see them, support the need to individualize instruction. One of these is the development of individuality. The press for conformity is strong in our culture, and certainly some conformity is essential for living in any society. We are not faced, however, with choosing individuality or conformity but rather with the issue of balance and meaning. Other purposes of the school include promoting an understanding of the world and encouraging each child's self-fulfilment and competency. In order to develop individuality and feelings of competence and to move toward self-actualization, children need to learn how to learn, to think independently, to make choices, to plan, and to evaluate'. (1970, p.101).

Above are just a few examples given on some reasons for the need of individualized instruction. There is no doubt today that individualized instruction is becoming a very popular system of instruction for the future. This claim is evidenced by enormous numbers of institutions in many countries having individualized instruction in operation as can be seen in the 'Aspects of Educational Technology, Volume X, 1976.

2.8 APPROACHES TO INDIVIDUALIZED INSTRUCTION

As presented above it can be recognised how educators conceptualised problems and give reasons for the need of individualized instruction. Because they have different ideas and assumptions about education and individual differences, they put forward different types of individualized instruction as already presented previously.

Wolfson (1970) states four assumptions for the long-term educational goals to individualized instruction:

1. For real learning to occur, the learner must see a purpose and meaning in the learning experience.
2. No best method exists for all teachers and all pupils for any particular subject.
3. The way a teacher interacts with his pupils affects the amount they learn, their feelings about learning, and their feelings about themselves.
4. There is no best structure in the discipline nor a best sequence in skill development.

Howes (1970) mentions three approaches which have added power and impetus to the search for the meaning of individualized instruction.

1. The curriculum reform movement,
2. The development of technology adaptable to education,
3. Concern for the disadvantaged pupils and the concomitant desegregation moves.

Analysis and examination of the predominant characteristics underlying the assumptions of the different definitions reveal three major modes of individualized instruction. Howes categorizes these three modes as: adjusted instruction, differentiated instruction, and independence and self-direction.

2.8.1. ADJUSTED INSTRUCTION

This was probably the first major attempt to individualize. It is based on 'lockstep' curriculum organized on the basis of adult interests and needs. Grouping learners into classes to reduce the range of differences in pupils such as being mentally retarded, physical handicapped, etc. Other efforts to adjust instruction focus on classroom grouping plans (subject areas), homogeneous grouping, non-grading, multi-grading, and team-teaching.

2.8.2. DIFFERENTIATED INSTRUCTION

The emphasis of this mode of individualized instruction is placed on accounting for individual differences in designing teaching and carrying out its purposes. It also emphasizes the role of the teacher in providing for, dealing with, and meeting or accommodating instruction based on those differences.
To accommodate a rate of learning, the learner is in one way or another free to move ahead through common programmes and materials as fast as he can. He may work independently of other class members, receiving teacher help as needed, until the work assignment has been completed or mastery attained.

To accommodate learning ability, plans focus on altering the sequence or content on an individual basis, the use of different books and materials, varying the nature of individual assignments, etc.

To accommodate a learner's interest, grouping is made on a basis of interests, independent study or selection of materials.

2.8.3. INDEPENDENCE AND SELF-DIRECTION

This mode of individualized instruction is different from those mentioned above on as the emphasis is not based on individual differences, but learner autonomy. The following lists the concepts involved and also includes other important dimensions:

1. We note that the concern is not with differences but with individual development and becoming.
2. Our concern relates to societal goals for the functioning of the individual. These goals stress the development of individuals who are self-directive, self-disciplined, self-responsible, and capable of making intelligence choices.
3. We believe that the ends and means are interwoven and inseparable. One must be co-ordinated with the other.
4. Last, we are guided by the belief that virtually every individual needs, and can substantially benefit from, a mode of instruction which gives more autonomy to the learner.

It is apparently clear that modes of individualized instruction are dependent upon the assumptions and conceptualizations of educators who design teaching. These differences bring out different types of individualized instruction which have values in their own right.
2.9 HOW CAN WORKSHOP TRAINING BE INDIVIDUALIZED?

Based on my own perception I believed individualized instruction was an efficient solution to the present workshop training problem at the Institute previously mentioned in the problem analysis. There is a need to individualize the training due to differences in strength, style, capability, curiosity and interest among students; even though, they may share the same attitude towards their trades. It is not only individual differences that must be taken into account, but also their sense of awareness, responsibility, enthusiasm, and co-operation must be developed and nurtured.

I now outline some constraints and limitations of the present curriculum and administration, my philosophical standpoint, and some approaches to individualized instruction and training.

2.9.1. CURRICULUM AND ADMINISTRATION CONSTRAINTS

Within the present workshop training system the following conditions are fixed:

1. Course context and training exercises.
2. Workshop rules and regulations.
3. Grading systems.
4. Timetable and semester length.

These are constraints and limitations for individualized instruction because students must comply with them and have no possibility choice regardless of their interests, willingness or comfort.

2.9.2. PHILOSOPHICAL STANDPOINT

Despite these constraints and limitations there is still room to manoeuvre within the system of teaching and training workshop skills. I believe, individualized instruction could provide students with the following:

1. Self-responsibility for their duties and tasks.
2. Self-determination as to their methodologies, plans, and
solutions to problems.
3. A self-conceptualisation concerning their career and prosperity.
4. A more democratic environment.

2.9.3. POSSIBLE APPROACHES FOR DESIGNING INDIVIDUALIZED INSTRUCTION

Based on the present course contents, individual differences and my beliefs the following are approaches for the design parameters necessary to individualize teaching and training:

1. Fixed goals and objectives.
2. Pre-determination of the sequence of training.
3. Pre-determination of mastery level.
4. Provision of student autonomy.
5. Provision of enrichment tasks.
8. Provision of freedom in respect to working hours.
10. Provision of shared assessment on produced work.

The systematic design and construction of my training system will be based on these parameters, and discussed in the next chapter.
PHASES IN SKILL LEARNING

Although certain inborn abilities play an important role, performance on most psychomotor tasks is largely a function of habits and skills acquired on the task itself (Fleishman, 1967).

In acquiring any complex skill, a number of learning phases are recognizable. Fitts (1964, 1965) describes three stages of development in the learning process of skills, going from learners' helplessness and dependence on many sources of information to independence and self-controlling operations. It gives a general descriptive overview of the nature of the acquisition of skills, from initial performance level to the most proficient.

The three stages described below are overlapping and not distinct. The learner's progress from one stage to the next is continuous rather than discrete.

1. **The Cognitive phase**  Cognition processes are heavily involved in the early stage of performance. The learner cognizes or intellectualizes the skill to be performed. He establishes an internal model or internal standard by means of which he can judge his performance.

2. **The organizing phase**  In the organizing phase, emphasis is on the actual practice of the skill. The correct pattern of motor action are refined and fixed. The length of this phase varies for different skills, but generally lasts until the skill is automatic.

3. **The automation phase**  This phase is characterized by rapid, automatic performance. Errors are at a minimum. The skill becomes not only well integrated but resistant to the effect of stress and interference from other activities that may not be performed concurrently.

MASSED VERSUS DISTRIBUTED PRACTICE

In relation to time distribution training can be divided into
'massed practice' and 'distributed practice'.

1. **Massed practice**  This is characterized by consistent and continuous practice of the skill to be learned without any intervening pauses.

2. **Distributed practice**  The skill is practiced in short and frequent practice sessions. These practice periods would be divided by rest intervals or intervals of alternative skill learning.

Singer (1975) mentions that attempts to improve learning efficiency in any field of activity must consider the problem of the optional spacing of training sessions. He also points out that leading physical educators are in general agreement that short, frequent performances are more favourable and profitable to learning than long sessions crowded into a brief span of time.

Davies (1971) has the same opinion and states that spaced practice tends to be superior to massed practice, particularly in the early phase of training.

There are a number of experiments in favour of distributed practice as opposed to massed practice. Ammons (1951) had two groups of ten subjects perform thirty-six practice trials on the pursuit rotter. The massed practice group was not allowed any rest between trials, whereas the distributed practice group paused for five minutes between trials. Distributed practice was favoured under various performance criteria used by the experimenter.

Lorge (1930) studies the effects of continuous practice for twenty trials compared with the effect of practice in which a rest of one minute or a rest period of one day intervened between each trial. The tasks used in the experiment were mirror drawing. The results indicated that distributed practice (one minute and one day rest period) is superior to massed practice.

Kientzle (1946) studies the relative effectiveness of distributed practice by varying the rest periods and keeping work period constant. The task in this experiment was learning to print random sequences of letters upside down. It was found that short rest periods resulted in great improvement in performance compared with no rest, but not much further advantage is gained by longer rests. These results are
typical even when the work cycles are longer. Relatively short rest periods are really maximally effective in producing recovery from any harmful effects of continuous work. The experimental literature on perceptual-motor performance in general does not reveal residual detrimental effects of massed practice, as might be expected from the theory (Bilodeau and Bilodeau, 1961).

Clay (1964) has summarized the results of experiments on massed versus distributed practice, and finds that in the majority of cases distributed practice proved superior, particularly in the early stages. In unduly long sessions, trainees not only fail to improve, but their performance may deteriorate; after a rest, they may start again at a higher level of performance (Seymour, 1966).

Inspite of the general findings indicating the preferability of some form of distributed practice over massed practice, skill retention is not favoured so clearly under one practice condition. Singer (1975) mentions that 'after a rest interval, tests of retention usually indicate a lessened dissimilarity in performance between groups trained under massed and spaced practice conditions'. This is evidenced by Jim Whitely's (1970) experiment on the 'Effects of Practice Distribution on Learning a Fine Motor Task'.

There is some evidence to suggest that the performance levels obtained by spaced practice are not always so well sustained subsequently. Gange', (1953) states that 'performance requirements in learning of motor skills are not found in all studies, that they occur in early in the course of learning, and that when retention is measured, the results depend upon the massing or distribution prevailing in the test conditions'.

2.12 THE WHOLE VERSUS PART-METHOD OF TRAINING

Most skills can be taught either in their entirety or broken down into parts. The division between 'part' and 'whole' is arbitrary. For example, Seymour (1966) writes '...on the one hand,... almost any whole can be considered as part of something greater, and, on the other, even if a task is divided into many parts, it is still possible to regard each part as a unit in itself'.

Some researchers have attempted to combine the feature of both part and whole methods, creating whole-part and progressive part methods.
In whole-part method, according to some researchers, may describe the situation where in the learner views the desired end product and then practices each part until the skill is finalised.

For the progress-part or continuous-part, the learner is required to practice the preceding learned units along with each newly introduced unit.

There are a number of studies on part and whole methods which have conflicting results. For example, Annett and Kay (1965) suggest that if the elements of a task are highly independent, the task should be learned as a whole, but that where the elements are inter-dependent the task should be learned in parts. Briggs and Naylor (1962) investigated the relationship between task complexity, task organization, and the method of training, and found that for highly organized or integrated tasks a 'whole' method was superior, but that for relatively unorganized tasks, 'part' methods were increasingly beneficial as the complexity of the task increased.

Seymour (1954) examined part-whole training in the operation of a capstan lathe and found that where the task cycles contained both harder and easier elements it was more economical to learn the harder ones separately. No difference between the methods was found as regards speed of completion of a simple task where movement predominated and where the perceptual discrimination requirements were limited. Where a higher level of perceptual discrimination and coordination was demanded, the part method proved to be superior because it enabled greater attention to be concentrated on the difficult elements. In the whole method, practice of the difficult perceptual elements involves wasting time on the simple elements which have been already mastered.

2.13 KNOWLEDGE OF RESULTS

Knowledge of results is important in learning or acquiring skills. Mace (1935) found that knowledge of results was more effective than financial incentives in the acquisition of motor skills.

The term 'knowledge of results' is defined by Singer (1975) as a form of reinforcement, for the individual is informed as to correctness or incorrectness of his responses. Knowledge of results is also known as feedback which basically refers to the same state of affairs.
Holding (1965) and Seymour (1966) suggest two main types of knowledge of results.

1. **Intrinsic** This refers to the internal information (e.g., visual, tactile, etc.) connected with the activity. For example, the lathe operator reduces the depth of cut of the turning tool as he felt too heavy resistance on the feeding hand-wheel.

2. **Extrinsic** This refers to additional external information given to the operator, e.g., by an instructor.

Usually in training, knowledge of result or feedback is provided by the instructor, but there are possibilities of intrinsic feedback. If the learner knows clearly what he has to achieve (e.g., through specifications for accuracy, surface quality, etc.) and at the same time he knows how to correct mistakes (i.e., knowledge of strategies) then he can 'shape' himself. Hermanns et al. (1976) mentions that the beginner lacks the knowledge of strategies as well as the ability to assess his own progress. Comprehensive information about the objectives to be achieved should be provided from the instructor's side.

Practice alone does not always make perfect. Related technical knowledge can help to identify mistakes, prevent them, and give an idea about remedies for feedback operations. Demonstration charts, exhibition of typical works, illustrated manuals can help the learner to get reinforcement and shaping without the teacher's direct interference and guidance.

It is frequently recommended in textbooks that knowledge of results should be as immediate and specific as possible. Elwell and Grindley (1938) emphasized the value of information which was specific to the situation in the sense that it specified not only 'right' or 'wrong' but also the direction to be followed to move from 'wrong' to 'right'.

Annelt (1961) questions the evidence supporting the view that the immediacy of knowledge of results increases its value, but there would appear to be little advantage in delaying it in the practical situation in training.
Clay (1964) has reviewed research on knowledge of results in relation to operator training, and the finding may be summarized as:

a) Information during practice should help the trainee to make correct responses and to eliminate error, and should provide knowledge of how his performance compares with the standard he is aiming at.

b) The information should provide a measure of achievement in time and error, but the latter should be augmented by sufficient information for correcting errors.

c) Information given more frequently results in more rapid learning. Any delay in the supply of the information results in less rapid learning. (After Seymour, 1966).

2.14 TRANSFER OF SKILLS

Almost all learning is based on the concept of transfer. Transfer implies the influence of a learned task on one to be learned or the utilization of formed responses in a new situation related to the one in which they were learned.

Seymour highlights five questions of the possible effects of skill transfer in training.

1. New workers have always had prior experience of some activities and have acquired some skills - will these, if transferable, be of value in mastering the new job?

2. No worker remains indefinitely on the same job - will skills acquired on the old one transfer to the new one?

3. No job is ever static - will skills already acquired help or hinder when the task content is changed?

4. It is sometimes desirable to train operatives on parts of a task before proceeding to the whole - will the skills acquired on the parts transfer to the whole task?
5. Training devices, models, 'mock-ups' or exercises are frequently used in industrial training schemes - will the skills acquired in these activities transfer to the real task?

It is quite possible that one may think that the ability to perform certain elements which are similar to others might be transferable. Two examples given by Seymour demand consideration of the conditions affecting transfer.

Where identical elements exist in two tasks, the skill involved may be transferable. For instance, when operatives are changed from one operation on a capstan to another, they attain full competence on the new operation much more quickly than new workers would. But many similar activities contain also completely antagonistic elements. For example, machinists who have used a manual sewing machine are frequently hampered by their tendency to stop powered machine manually with the hand-wheel instead of using the foot pedal.

2.14.1 CONDITIONS AFFECTING TRANSFER

There are numerous conditions associated with, and which may potentially affect, the transfer effects of one task to another.

1. **The similarity between the tasks**
A greater resemblance between task elements, their respective stimuli and responses, will result in a greater degree of transfer. For example, Ammons et al. (1958) trained their subjects on varying speeds of the pursuit roter. Transfer effects were found to be proportional to the similarity between the speed rates of any two tasks.

2. **The amount of practice**
More practice on a task that might be positively influence performance on a second task will result in performance in the expected direction. Even experience with elements or components of a task can facilitate the learning of it. For example, subjects practicing on specific perceptual components of motor skills showed the advantages of this experience when compared to control subjects. (Vincent, 1968).
3. The method of training
Some investigators have looked into the matter of whole-versus-part learning methods and their relative efficiency in facilitating transfer. Briggs and Water (1958) using simulated aircraft control dynamics, found that it was important to practice the whole task if the highest transfer retention is to be realized. Part practice does not integrate component skills. For transfer purposes, the authors recommend that the whole task be simplified rather than fractionalized. Briggs and Naylor (1962) tested their subjects for transfer on a three dimensional tracking task learned under different methods. The whole and progressive part methods were equally significantly better than the pure part and simplified whole methods for transfer effectiveness. The difference between the transfer effect of training and that of practice, as mentioned above, has been closely investigated by Cox (1934). The practice group has more or less mechanical repetition of a task and without instruction. The training group has received instruction in the best methods of carrying out the work and in the general principles through formal exercises. In this experiment the trained group showed a considerably higher gain in performance, and it was statistically significant in all operations, except one where it was very nearly so.

4. Intent of transfer
If the instructor indicates the elements common to two tasks and provides the basis for insight and understanding, the learner will probably made greater use of what he has learned on the prior task when it comes time to perform a related second task (Singer, 1975). Knapp (1963) has reviewed the literature on transfer with respect to athletic skills, and concludes that transfer 'can take place through an understanding of the fundamental principles of movement, but that transfer is more likely to have beneficial effects when teaching of the right type is used'.
5. **Levels of task difficulty**

A great degree of transfer from difficult tasks has been noted by Welford (Szafran and Welford, 1956) and in control tasks by Crossman and Cooke (1962). Welford points out that this transfer does not follow from the initial task upon the performance of the second. An operator will tend to deal with a second task using the comprehension and organization derived from the first, and as this receptor comprehension and effector organization is more easily built up than modified, performance of the difficult task first provides the operator with a greater ability to tackle the second. Again, a more difficult task will demand a higher standard of performance and level of care than a simpler one, and once this standard is attained it will tend to continue for the easier task.
This chapter is divided into two sections. The first section will present a survey of the literature on many aspects concerning the design of training courses, learning theory, learning-teaching aids, and evaluation. Topics included in this part are, for example, the framework of training, motivation theory, the systems approach, network diagrams, information mapping, etc.

The second section, (Section 4 onwards) shows the application of the ideas, concepts and principles mentioned in the literature survey to the design and construction of my training system, learning materials and evaluation.

SECTION 1 LITERATURE SURVEY

3.2 FRAMEWORK FOR CONSIDERING TRAINING

Usually one will go straight to a model of systematic design when dealing with designing a learning or training course. But, I will go back one step and start with a framework for considering training.

Wheeler's (1966) framework for analysing training problems in an organization, classifies the components of an organization into policy, technology of training, and motivation of the individual. This framework regards learning a job as a process of socialization, which suggests that the individual changes his behaviour to conform to a certain expectation - of a manager or a teacher or an administrator. Employees or students alike are expected to be able to see what is expected of them from a given policy, to learn or perform what is expected of them from a given training, and to want to learn and

1. Socialization is a process by which the individual acquires knowledge, attitudes, skills to meet the expectation of those who influence his behaviour. (Morea, 1972, p.203).
perform what is expected of them from given rules or conditions.

### 3.2.1. POLICY

It is through an administrator or teacher policy that training techniques are converted into training procedures, and thus training is integrated into the school or workshop. King (1964) proposes six headings in which training policies may be considered:

1. The analysis of needs.
2. The formation of aims and principles
3. The establishment of an organizational structure suitable for implementing training policy.
4. The determination of relevant procedures.
5. The selection and training of staff.
6. The establishment of review procedures.

### 3.2.2. THE TECHNOLOGY OF TRAINING

This is concerned with the transformation of training policies into procedures of training. Rodger (1950) suggests the training procedures in terms of:

1. What needs to be taught.
2. How it should be taught, and
3. The ways of reporting on training.

I will discuss these aspects later by using a systems approach technique.

### 3.2.3 MOTIVATION OF THE INDIVIDUAL

This component of the training framework is concerned with the capacity of the school or workshop to motivate the learner. I will discuss four theories of motivation: Kelman's, Maslow's, Herzberg's and the 'Learning Process' theory.

a) **Kelman's Theory** Kelman (1961) suggests three processes of social influence by which the behaviour of an individual is influenced
and motivated by another person or a group. These are: compliance, identification, and internalization.

Compliance can be said to occur when an individual accepts influence from another person or a group because he hopes to achieve a favourable reaction from the other. There are three consequences in this case. Firstly, it means that learning will occur, and the learned behaviour continue only when whoever rewards or punishes is likely to know about it. Secondly, since with compliance whatever the individual does is instrumental and motivated only by the payoff, it continues only as long as it seems the best way to get what he wants. Thirdly, the behaviour that is learned because of compliance is usually specific to a situation.

Identification can be said to occur when an individual adopts behaviour derived from another person or a group because this behaviour is associated with a satisfying, self-defining relationship to this person or group. Behaviour that results from identification may change when the person no longer regards it as likely to maintain satisfying, self-defining relationships. Behaviour, skills and attitudes originating through a process of identification do not become embedded in the personality core.

Internalization can be said to occur when an individual accepts influence because the induced behaviour is congruent with his own value system. If certain behaviour and attitudes have been acquired through a process of internalization, they will affect the individual in any situation he sees as related to those of his value they accord with.

b) Maslow's Theory Davies (1971) states that 'when a person is actually motivated he is in a state of tension, and is ready to undertake a course of action consistent with his feelings'. Motivation, in effect, involves fulfilling a set of needs. Maslow (1954) categorizes five basic sources of human motivation as follows:

1. Physiological needs (eg., self-preservation, procreation)
2. Safety needs (eg., avoiding danger, security etc.)
3. Belongingness and love needs (eg., social needs, love, affection, etc.)
4. Esteem needs (eg., appreciation, recognition, etc.)
5. Need for self-actualization (a need to become everything
Davies, distinguishes the first three lower order needs as 'extrinsic' motivation, and refers to 'context' factors which are imposed on the task or the student by a teacher or other external agent in forms of rewards or punishment. The last two higher order needs he considers as 'intrinsic' motivation, and refers to 'content' factors which are inherent in either the task itself, such as the precision required, or in the student such as discovery and curiosity.

c) **Herzberg's Theory** Herzberg (1966) produced the 'Motivation Hygiene' theory which has implications for organization, administration, working conditions, interpersonal relationships, and personal feelings. His theory is originated from his interview studies with his associates in 1959. From those studies he found that good feelings of persons were associated with activities in which they worked particularly well, and bad feelings were associated with background events and how they were being treated.

Based on his interviews Herzberg concluded that people have two contrasting needs: motivation and hygiene.

Motivation involves those feelings of accomplishment, recognition, responsibility, personal growth, and development that comes from work which offers sufficient challenge, scope and autonomy, and in which people are pushed to the limits of their capacities.

Hygiene factors are concerned with company policies, administration, supervision, working conditions, interpersonal relations, remuneration, status and security.

Davies (1971) concludes from this theory that 'hygiene factors are the prerequisite of effective motivation, but they are not themselves motivating'.

Motivators, when present, make a person happy, give rise to feelings of satisfaction, and to increased productivity. These feelings are long-lasting. Motivators, when not present, will not make a person unhappy. Whereas hygiene factors, if they are at a low level, will make a person unhappy. They have a general depressing or limiting effect on both a person's performance and his attitude towards a task. Attention to these factors will prevent a man from feeling unhappy, but they will not make him feel happy. These feelings are not long-lasting.
The three motivation theories presented thus far, highlight principles, concepts, conditions and consequences of motivation, which to a large extent are imposed upon an individual. The emphasis of the theories is concentrated on administration, working environment, interpersonal relations, personality and basic human needs rather than on any learning process. Therefore, we on go to discuss motivation in the light of learning processes.

**d) Motivation — Learning Process**

Prior to any discussion I put forward views of some writers in contrasting social motivation and learning motivation. Gagné (1975) states 'Although the existence of social motivation, often related to affiliative needs, is generally recognized, some writers consider it of considerably lesser importance to school learning than the motivation of task mastery and achievement'. Ausubel (1968, pp.363-433) points out that social motivation does not always constitute a dependable basis for learning readiness.

Motivation in learning process can occur in many stages and is dependent on many factors. Motivation may be dealt with in the following sequence: level of aspiration, task difficulty and achievement.

1. **Level of aspiration**

Before performing a task, one usually formulates hypotheses about the chance of success, such as 8 out of 10 shots on a target. The setting of goals in this case is termed 'the level of aspiration'.

An individual's level of aspiration for a given task reflects an optimism or lack of it when faced with the challenge. It also denotes an attitude toward the task. It could indicate a level of performance. For example, Worell (1959) found that students whose aspirations were related to previous performance and who did not wish to achieve more than had been already received the highest college grades.

There is, however, no universal acceptance of what the intended level of attainment should be. And there are contradictory findings on this aspect. Atkinson (1957) found that the maximum level of performance was obtained when the probability of success was moderate (0.5) and he predicted that it would be uniformly lower as the probability changed in either direction. Meanwhile, Locke (1966) observed a linear relationship between intentions and the
actual level of performance. That is, the higher level of intended achievement resulted in higher levels of performance. Later Locke and Bryan (1966) verified these findings and it was found that performance goals influence the level of performance. The subjects with specific but high goals did better at a task than those who were told just to do their best. Singer (1975) infers from this finding that setting students precise, high but obtainable goals may be more effective as a learning technique than haphazard methods of motivation.

2) Task difficulty Motivation effects depend not only on environmental manipulation and the individual's personality, but also on the nature of the task itself. This can be related to the intrinsic motivation through achievement of the task and its consequence on individual feelings.

Ausubal (1968) believes that the advantages of achievement motivation for learning is due, firstly to the fact that such motives are intrinsic to the task itself, and hence the reward (eg. attainment of new knowledge or skill) is capable of wholly satisfying the underlying motive. Secondly, achievement is ego-enhancing, because the status achieved by the individual is in proportion to his achievement or competence level, which directly affect his self-esteem and feelings of adequacy. Gagné (1975) also points out that this view of motivation emphasizes the power of intrinsic and positive motives, including curiosity and exploration, as well as mastery.

For skill learning, there are relationships between the difficult level of the tasks and the level of motivation. Singer (1975) contrasts the effects of motivation on simple and difficult tasks. Activities on simple tasks would probably benefit from the presence of the highest levels of motivation; and effort, as reflected by motivation, may determine final performance. Whereas activity on a difficult task better suggest the controlled use of motivation. A reasonable degree of motivation needs to be present for arousal and cue attention, discrimination and selection purposes. But too much motivation, either internally produced or externally imposed, will most likely hinder the control processes underlying skill manoeuvres.

3) Achievement Motivation Successful performance by an individual leads to motivation in learning for him. From results of studies on industrial tasks Clay (1964) indicates that 'experience of
success is an important factor in increasing the trainer's motivation.

In the process of achievement motivation 'reinforcement' plays an extraordinary role. Nölker and Schoenfeldt (1980) state that 'a person who has such a pleasant experience of success will quite understandably have a tendency to repeat the activity again and again'. Continuity of positive reinforcement for a long period of time will stabilize the structure of learning and performance motivation; a long-term development of this expectation of success will eventually generate self-confidence. Unfortunately, continuity of failure for a long time will create a learning barrier and eventually refusal to perform.

Gagné (1975) points out that 'motivation to achieve' is carried much beyond the idea of 'task mastery' by some theorists. It is the view of McClelland (1965) that a combination of techniques, including those leading to a clear definition of an individual's goals, perception of self-improvement, an increasing trend toward assumption of responsibility for one's performance, and a supportive social environment, can lead to the acquisition of persisting motivation for achievement. Achievement motivation is considered to be very crucial for the development of a 'continuing self-learner' and such a development is often stated as one of the most important goals of education, particularly in individualized systems.

3.3 SYSTEMS APPROACH

Current changes in education and social atmosphere have led to the emergence of complex problems which may no longer be solved simply by a mere intuitive judgement or educated guesses. This called for the adoption of scientific approach to solving problems which could improve both the process and the outcomes of decision-making curriculum development, planning, implementing educational and training programmes and the allocation of scarce educational resources.

The term 'systems approach' is used in many context and has a variety of meanings (Bratten, 1969). Most writers agree that the concept includes formal problem-solving. In reference to the educational context the systems approach indicates a process for the application of logical thinking in the solution of problems in education.

The term 'system' is very general. Most writers will agree that a system is a set of parts united together in an interactive and
interdependent manner to achieve specified objectives.

Thus, the systems approach is a technique of understanding, predicting and controlling the interaction and interdependence of the majority parts of a system in a given situation to achieve specified objectives (Unesco, learning to change, 1978). The systems approach discussed in the following is limited to a systematic design of a learning-training system.

3.3.1 THE STRATEGY OF LEARNING-TRAINING SYSTEM DESIGN

In learning-training systems for an industrial skill course, certain factors need to be taken into consideration. These factors include the requirements of the task, the needs and limitations of the learners, and the social-cultural environment in which they are a part. These should be carefully scrutinized in a situation analysis which must precede the process of designing the programme.

In much of the literature can be found many similar systematic models of course designing, such as those of Tilley, 1968; Boydell, 1973; Gagné and Briggs, 1978; Mager and Beach etc. These models can be categorized into three phases. Many writers, however, use different terms. For example, Mager and Beach specify a model for course development which consists of (1) preparation, (2) development, and (3) improvement. Whereas Davies et al. present a learning system design plan as consists of: (1) analysis system requirements, (2) design system, and (3) evaluate system effectiveness.

One example of a systematic model of an instructional system is presented by Gagné and Briggs when four levels are distinguished consisting of 14 design stages as follows:

a) **System Level**

1. Analysis of needs, goals and principles.
2. Analysis of resources, constraints, and alternative delivery systems.
3. Determination of scope and sequence of curriculum and courses, delivery system design.

b) **Course Level**

4. Determining course structure and sequence.
5. Analysis of course objectives

c) **Lesson Level**

6. Definition of performance objectives.
7. Preparing lesson plan (or modules).
8. Developing, selecting materials, media.

d) **Systems Level**

10. Teacher preparation.
11. Formative evaluation.
12. Field testing, revision.

Details of the concepts and principles of these stages will be found in the next discussion. But the model of the system design will be based on my workshop training situation.

3.4 **SYSTEM DESIGN**

The system diagram of an instructional system shown below is devised by the Author, based upon observation of the workshop training situation at the Institute. The principles involved in each stage of the system diagram will be dealt with accordingly.
The system diagram of the workshop training course consists of 9 successive stages:

1. Job Analysis
2. Task Analysis
3. Identifying Training Needs
4. Selecting the Training Programme
5. Formulating the Training Programme & Objectives
6. Sequencing Learning & Training Programme
7. Design & Selection of Materials & Media
8. Testing the Training Programme & Materials
9. Evaluating the Training Programme & Materials

Diagram 3.1 System diagram of the workshop training course.
3.4.1 JOB ANALYSIS

This stage is equivalent to stage 1 of Gagné and Briggs model presented previously. Training needs of students can be defined as a discrepancy or gap between the present performance before training and the performance called for in the course description (course objective, or syllabus) which constitutes the desired performance of students by the end of training.

Training needs in industry are often derived from a job (Gagné and Briggs, 1979). Many writers define the term 'job' differently. For example, the British Ministry of Defence (1970) defines job as: 'All the task carried out by a particular individual in the completion of his prescribed duties and the inter-relationship between those tasks and the social and physical environment in which the job is carried out'.

Sometimes an occupation is referred to as a job, Boydell (1973) mentions: 'Checking the brake linings would be considered a 'task' within the job (i.e. occupation). But in other cases it is an element within an occupation, as when the National Institute for Skill Development of the Department of Labour in Bangkok (1977) defines job as: a goal directed activity consisting in an occupation...a cluster of functions grouped to carry out a specific activity'.

Despite different definitions for the term job, the concept of job analysis in most cases means the breakdown of a component into its smaller constituents - known in this case as tasks. (e.g. Ministry of Defence, 1970; Davies, 1971). The Ministry of Defence defines job analysis as: 'The process of examining a job in order to identify its component parts and the circumstances in which it is performed'.

In the present workshop training course, all students are given the same production project. Analogously to job analysis, the breakdown of the production project will reveal a number of production processes which students must carry out.

The method used to aid the analysis of production projects is an examination of a sequence of operations. Diagram 3.2 shows an example of a drawing of a machine part to be made. The sequence of operations given in the middle column is formulated from the drawing and then transformed into suitable production processes in the right hand column.
Diagram 3.2  An example of identifying production processes in workshop training by means of a sequence of operations for the product to be manufactured.

2.4.2. TASK ANALYSIS

The training needs required by students can be identified in terms of knowledge, skills, and/or attitudes. A further breakdown of each task will meet the requirements. This is known as 'Task analysis'. This is also applicable to the 'analysis of production processes'.

The knowledge required in industrial training can be categorized into job knowledge, quality knowledge, diagnostic knowledge, and factory knowledge. (E.J. Singer, 1970). Notice that factory knowledge is derived from the analysis of the organizational structure and the administration of a factory.

Skills in this context imply only psychomotor skills - rather than cognitive skills or social skills.

Many management techniques may be adapted for use as methods of task analysis to identify contents of knowledge and skills. Some of the methods that have already been used successfully are:

a) Systems thinking.
In relation to production processes I favour systems thinking and I shall briefly outline it here.

a) **Systems thinking** The basis of this technique is that everything can be visualized as:

1. A system in itself.
2. Part of a larger system.
3. Containing sub-systems within itself.

A systems diagram is drawn to show the boundaries of the system under investigation and the position of all the sub-systems and related systems. Once the diagram is completed it is possible to identify, the actions, interactions, and feedback between systems and sub-systems.

The systems thinking technique as used in an industrial production system might be looked at in terms of Diagram 3.3.

![Diagram 3.3 Systems thinking diagram of a production process.](image)
The system can be described as: the operator reads and follows a production plan, checks materials in relation to the plan, operates and/or handles tools or machines to produce the material to specified shapes and size according to the plan, and from time to time the operator checks and measures the work to observe any discrepancies occurring so that he may adjust the machine or his use of the appropriate tool in order to correct faults until the work has been completed.

The systems thinking diagram facilitates understanding and leads to a series of logical questions, such as:

i. What information is contained in the production plan?

ii. How can the operator read the information?

3.4.3 IDENTIFYING TRAINING NEEDS

Once the task analysis (knowledge and skills) has been completed, but before the training programme is formulated, it is necessary to isolate and identify those elements of knowledge and skills that require actual training.

Not all knowledge and skills of task analysis require training due to two main aspects.

a) The merit of the intended knowledge, and skills.

b) The characteristics of students.

a) The merit of the intended knowledge and skills It is recognizable that any particular piece of knowledge or skill will differ from others according to:

1) Its difficulty level.

2) Its level of criticality or importance.

3) Its frequency of occurrence.

(Mager and Beach).

It will not be wise to spend a lot of time in teaching or training students on every difficult skill which will be performed only a few times, or to leave out some more easily taught knowledge which might be critical, say, to the safety of persons or equipment.
These three aspects are in fact selecting criteria for the first stage of intended training needs. A question then arises, 'How should knowledge and skills be selected?' The method used in this case consists of two successive steps.

Firstly, it is to assign a score from 1 to 5 to each identified piece of knowledge or skill in relation to its difficulty, criticality (importance), and frequency.

Secondly, it is to make a judgement for each identified piece of knowledge or skill by using the decision aid shown in Diagram 3.4.

Diagram 3.4 Decision aid diagram for the selection of training needs.
Any co-ordinates that fall within the 'YES' zone will be regarded as intended training needs, whereas those that fall within the 'OMIT' zone will be rejected.

Since there are two decisions to be made on this diagram, it is possible in some cases for discrepancies to occur. In that case the knowledge or skill concerned will be accepted as an intended training need. This is because, I believe underestimating results in working efficiency is less severe than over-estimating, which results in excessive costs in effort and resources. This view is congruent with Davies's (1977).

b) Characteristics of incoming students

Although the intended training needs have been identified, the current characteristics of incoming students have not yet been taken into account. It is probable that some intended knowledge or skills have already been acquired by students. The training course to be designed must be suitable for the students concerned otherwise it will be wasteful and lead to boredom.

Thus it will be sensible at this stage to exclude that knowledge or skill which students already possess. A formula which can be used in this case is:

\[ TN = IT - A \]

Where TN stands for training needs, IT stands for intended training (ie. knowledge and skills identified from the decision-aid diagram), and A stands for knowledge and skill related to the task which the students already possess.

Information concerning the characteristics of incoming students or target population may be categorized as:

1. Physical characteristics This includes the general nature of students such as health, strength, agility, balance, and endurance.

2. Education The kind of education students have had to date particularly as regards knowledge or skills related to those needed in the training to be given.
3. **Motivation** This includes the desire, or eagerness to learn or to participate in the course.

4. **Interest** This covers those things in which students are interested, specially skills, and aptitudes.

5. **Attitudes, bias and prejudices** This deals with the convictions, bias, tendencies, habits and traditions of the students concerned.

Once the training needs have been identified, it is then necessary to communicate goals to the students, teachers, administrators, programme designers, evaluators and others concerned. Since these people have different roles and responsibilities. They will need different levels of information.

Two levels of information provided in this stage are: training goals, and training specification.

i. **Training Goals** These are general goals of the training. They provide a general description of the training needs, and express in terms of terminal student behavior, the scope and conditions to be fulfilled. (See the example in Appendix A5).

ii. **Training specification** This provides more details of the training. It is stated in behavioural terms of student performance in both knowledge and skills area. The contents of the training are arranged in specific production operations (See example in Appendix A6).

### 3.4.4 SELECTING THE TRAINING PROGRAMME

When the needs and goals have been identified, instructional planners need to pause and consider the following aspects:

1. Available resources, personnel and budget.
2. Available training time.
3. Related studies.
4. Delivery system for the training.
A training system may be defined as everything necessary to make stated goals operate as they are intended. In this respect a system may require a new building, more machines, staff, time etc. Unfortunately, such ideal requirements may not exist in the real situation. There are always problems, constraints and limitations already described in the background information.

At this stage, therefore, new innovations or some training requirements may be sacrificed. Failure to do this at this stage may result in various kinds of waste, as Gagne and Briggs (1979) mention: (a) equipment and materials sitting unused due to lack of supporting personnel, (b) laboratories not being used because supplies have not been budgeted for, (c) learning activities disrupted due to faulty planning of timetables, (d) goals not reached because essential prerequisite learning experiences were not provided.

By the time decisions have been made as to the required contents of the training programme, taking into account all constraints, limitations and innovations, the following remarks should be made about the training goals and training specification:

a) The compulsory training This must include those contents required by the training and which may be carried out with no interference or distraction from the constraints and limitations, and those which are crucial to successful results and thus a high priority.

b) The optional training should specify those contents which have low priorities, or might not be carried out successfully due to existing constraints and limitations.

3.4.5 FORMULATING THE TRAINING PROGRAMME AND OBJECTIVES

At this stage, there is a need to devise a training approach, and to state precise performance objectives which are sufficiently specific and detailed to show the stage by stage progress during training. At this stage the instructional designers must have sound knowledge and understanding of:

a) The performance objectives,

b) The conditions of learning, and skill learning.

c) The organization of learning.
d) The educational technology available (e.g. individualized learning, etc.)

On this occasion the first three aspects will be presented briefly.

a) Performance objectives The method of communication of the intended goals in a teaching-learning situation is by means of performance objectives.

There are two types of performance objectives. The first type (process objectives), assist especially in designing learning/teaching sequences, and the second (end or product objectives) assist in designing evaluation tools to check if the learners have achieved the intended objectives (Unesco, Bangkok, 1978).

In writing learning objectives, the total statement should specify:

-What the learner is expected to be able to do;
-How well or to what standard the behaviour is expected to be performed; and
-Under what circumstances the learner is expected to perform the behaviour.

Logically, a list of objectives should be arranged in hierarchical order of concerned taxonomies (i.e., Bloom's, Krathwohl's, and Dave's). It is also desirable to state student performances in observable behavioural terms such as to be able to 'define' what the cutting speed is rather than to 'know' what the cutting speed is.

b) Conditions of learning The contents of different pieces of knowledge or a skill are conceivably different in their natures and properties. They will require different learning/teaching tactics to deal with them.

Gagné considered these types as hierarchical in the sense that they can be arranged in a series where all of the lower types contribute to and are included within the higher types. He has eight types of learning which are arranged in order of complexity as follows:

1. Signal learning
3. Chain learning.
4. Verbal association.
5. Multiple discrimination learning.
7. Rule learning.
8. Problem solving.

These eight types of learning require different conditions of procedures to deal with them, for example in respect to the methods of presentation, the amount of practice necessary for their acquisition, the sequence of progress, the resistance to forgetting, etc.

c) Organization of learning After the selection of contents, important decisions have to be made about their didactic organization. Two types of organization presented here are: linear, and spiral organization.

1. **Linear additive organization** This type of organization is characterized by a systematic division of topics or subjects into separate units and progress from general theories to the understanding of specific problems. This is a deductive approach.

2. **Spiral integrative organization** This type of organization starts with the specific problem. Experience and the solving of concrete problems lead step by step to a general problem-solving ability, with the help of which similar tasks can be later dealt with. This is an inductive approach.

Nölker and Schoenfeldt mention that the inductive approach is generally more advantageous than the deductive one, since it is superior in motivating learning and in providing the student with the opportunity to make his own contributions by linking his own experience with what he is learning.

Davis et al. consider the advantages and disadvantages of these approaches in learning concepts in the following terms. The deductive approach is most useful when there is a limited amount of instructional time. Using the deductive approach, students learn concepts more quickly than when using the inductive approach. However, the inductive
approach may aid in learning other concepts; i.e., in the inductive approach students learn how to learn. In contrast, the deductive approach may result in longer retention of learning.

### 2.4.6 SEQUENCING LEARNING AND TRAINING PROGRAMMES

Having decided on the topics or exercises to be given in the training programme, the next important decision is the order in which students will be presented with the various experiences involved.

It is in this area that there are a number of theories about hierarchies of learning, some of which conflict (Vaughan, 1978, p.16). Gagné (1979) states, 'It is very difficult to find a basis for correct sequencing of the entire set of topics for a course or set of courses other than a kind of 'common-sense' logical ordering' (p.140).

The approach I used for sequencing learning/exercise units in the training programme is based on my personal impression and understanding about the characteristics and properties of the contents of each unit. The sequence of units is decided by the following criteria:

1. Simple before difficult,
2. Known before unknown,
3. Concrete to abstract, or
4. The order required by the production sequence (e.g., one must drill a hole after the work surface is already prepared).

As the training system will be designed and implemented on the basis of an individualized instruction, it must take student choices into consideration as well. No two individuals will prefer exactly the same choice of sequence of learning activities. Another aspect of individualized instruction is that it is necessary to teach students to be self-reliant. These form the requirements for using 'network diagrams' in presenting plans of the training programme.

#### a) Network Diagrams

A network diagram is a method that was developed in order to control and organize complex operations in industry. The technique is sometimes called PERT (Programmed Evaluation and Review Technique), critical path analysis, or the critical path method (Vaughan 1978, p.7).
In a network diagram:

1. An arrow represents each activity.
2. These arrows proceed from left to right.
3. Nodes or 'sausages' indicate both the start and the finish of each activity.
4. The numbers in the nodes or 'sausages' designate each activity.

In interpreting a network diagram correctly, each activity must be read as proceeding from left to right. A principal conclusion of such a diagram will be that no activity can begin until all the activities leading to it have been completed.

The network diagram shown in Diagram 3.5 is given as an example. Notice that arrows in a simplified form of network diagram are replaced by straight lines.

Diagram 3.5: An example of Network diagram.

3.4.7 DESIGNING AND SELECTING LEARNING MATERIALS AND MEDIA

From the preceding stage a precise number of topics and exercises are definitely allocated on network diagrams. It is in this stage that the total design process needs to be carried out. The instructional designers must be able to combine knowledge of learning and design theory with their own produced experiences to meet the intended objectives of the training programmes.
In this stage, the following tasks are included for every learning material:

a) Listing the instructional events to be brought into play to accomplish the objectives of a lesson or unit.
b) Determining the materials and media to be used for each lesson or unit.
c) Designing and planning the learning activities, including producing plans for how media are to be used.

The term 'materials' used in this context refers primarily to instructional materials, whether in the form of printed or other media for conveying instructional stimuli and content which facilitate student learning and training.

As there are two aspects involved in this section - media and materials. I will present them separately.

a) **Instructional Media** One of the essential decisions to be made in instructional design is what medium to employ as a vehicle for the presentation of the stimuli which made up the instructional events.

There are plenty of possible choices of media for effecting these communications. However, the designers must be aware of constraints and limitations existing in schools or colleges. For example, it would not be wise to produce a television programme for students where the school does not have any television monitor and video recorder, or a film to be used by fifty or a hundred students in an independent study if not one of them knows how to operate a projector.

b) **Factors in media selection** Gagné and Briggs (1979) explain 6 factors in media selection:

1. Task variables.
2. Learner variables.
3. Assumed learning environment.
4. Assumed development environment.
5. Economy and culture.
6. Practical factors.
Allen, 1967 presents similar factors including: types of learning activities, characteristics of the learners, contents and required performances, teaching methods, and practical constraints.

1) **Choosing learning aids** As there are a large number of aids to choose from, and there are also many factors as mentioned above, the selection of these aids has a great influence on effective learning. Despite all these difficulties, teachers and instructional designers can still find a number of useful guides to select their appropriate aids. These selection guides can be found throughout the literature on the subject, e.g., Allen, 1967; Davies, 1971; Romiszoski, 1974; etc.

d) **Design and Selection Parameters** As mentioned earlier that I will use individualized instruction as a delivery system for the workshop training course. Clearly all learning materials and aids must be designed specially for individual students.

Taking all factors concerned as previously mentioned, the following are parameters for selecting and designing learning materials and aids:

1. Low costs.
2. Use of supplies available in the local market.
3. Light weight and compact size.
4. Suitability for use in the workshop and at home.
5. Simplicity of use without need of additional lessons, whenever possible, on the actual way of using.
6. Adaptability.

e) **Purposes of Media** In instructional events media can be used for two purposes, according to which they are called criterion media or mediating media (Gropper, 1966).

1) **Criterion media** Media are used as part of the criterion by which a student will be required to describe, interpret and manipulate in order to demonstrate that he has achieved mastery. Examples of this type of media used in my learning materials are a plastic model of vernier calipers and examples of tasks which are used to develop the ability to read the scale on vernier calipers.
2) **Mediating media** Media in other occasions can be used to facilitate student understanding, and gain insights in the knowledge of some phenomenon or event. Examples of this type of media used in my learning materials are illustrations given in study unit programmed texts (see an example of study unit programmed text in Appendix B1).

f) **Instructional Materials**

As individualized instruction will be used principally in the training programme, instructional materials will mainly be based on printed texts.

Since the learning topics and practice exercises are already identified from earlier planning stages, as well as the sequence of the training system, the design of learning materials in this stage is partly pre-determined.

However, there are a number of tasks to be carried out in designing individual learning units. These include:

1) Stating enabling objectives.
2) Constructing instructional events.
3) Designing the format of learning units.
4) Writing and constructing subject matter, learning activities, guidance, learning aids, feedback mechanisms, and assessment procedures.

1) **Stating enabling objectives** Objectives for each learning/training unit in this case are called 'enabling objectives'. They are different from those training stage objectives which are called 'terminal objectives', in such a way that successful achievement of students on each learning/training unit will enable them to perform successfully in the terminal training stage.

Enabling objectives are more specific for each particular learning/training unit. They are stated in observable terms indicating

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1. Gagné and Briggs (1978) call those objectives to be attained at the end of the course study 'target objectives', and those which must be attained during a course of study as 'enabling objectives', (p.97).
precise tasks, conditions, and standards of successful achievement. Details of objectives and contents of a lesson are derived from a careful analysis of the subject concerned. Gagne (1977b) suggests three kinds of analysis as follows:

i. **Information-processing analysis** Such analysis is carried out by identifying the sequence of decisions and associated actions involved in a performance that is a target objective. This kind of analysis is used in my practice units and exercise units.

ii. **Task Classification** Once target objectives have been identified, they can then be classified into one or more of the varieties of learning, i.e., intellectual skill, cognitive strategy, information, attitudes, or motor skills. The purpose of this classification is to indicate the necessary conditions for learning. This type of analysis is used in my study unit, and consolidating units.

iii. **Learning task analysis** Target objectives, including those which may have been revealed by an information-processing analysis, need to be further analysed to reveal their prerequisites.

2) **Constructing instructional events** Gagne and Briggs (1979) describe the five stages of instructional event as consisting of:

(a) gaining attention, (b) providing information about the objective; (c) guiding learning, (d) providing feedback, (e) enhancing retention and transfer.

Nölker and Scheonfeldt (1980) together with Wagener (1975) mention similar instructional events, which include:

i) **Motivation** The learner recognizes a fault, sees a problem, asks a question, attempts a solution and sets himself a goal.

ii) **Information** The learner collects information, looks for explanations, has insights, considers solutions, and develops a plan of action.
iii) Application The learner applies the knowledge he has collected, carries out an experiment or a piece of work, practices skills and tries out his insights in reality.

iv) Evaluation The learner considers the results, ensures consolidation of what has been learned through practice, works out the general validity of the process which he has learned in an individual case and submits himself to an objective evaluation of what has been learned.

This four stage learning method is adopted throughout in all my learning/training units.

3) Designing the format of learning units. There are three different formats used in the design of my learning/training units as follows:

i. Pictorial narrative format, used in study units.
ii. Information mapping format used in both practice and exercise units, and
iii. Linear programmed instruction format, used in the consolidating units.

i) Pictorial narrative format This is characterized by two columns of information. The left hand column presents a series of pictorial illustrations, and the right hand column a corresponding narrative information (see Appendix B1). This format is arrived at by adapting research results which indicate that a narrative text (structured) is superior to a descriptive text (unstructured) in terms of understanding and retention. (After Refa, 1975)

Research by Gropper (1966) also suggests that conceptual learning is significantly greater and quicker when pictorial presentations precede verbal or printed ones.

ii) Information mapping format Information mapping is a system of principles for identifying, categorizing, and inter-relating the information required for learning-reference purposes.

The arrangement of information blocks is dictated not only by logical analysis and classification of subject-matter concepts, but also by an analysis of the contingencies required for successful learn-
ing and reference use. Therefore, in addition to basic content material, information—map books will also have:

- introductory, overview and summary sequences
- diagrams, charts, trees
- feedback questions and answers in close proximity to material to be learned.
- self-tests and review questions
- tables of contents, alphabetic indexes and local indexes with connections to related topics.

(Horn, et al. 1969)

iii) Linear programmed instruction format. This is characterized by a series of successive pairs of stimulus and response, arranged in a linear sequence. Usually correct answers are given, and sometimes incorrect answers may be given as well.

3.4.8 TESTING THE TRAINING PROGRAMME AND MATERIALS

In this stage all learning/training programme materials and aids undergo a field test. A number of classes or schools may be involved in the implementation of the programme.

There are five main factors in programme implementation, required at this stage for a successful outcome:

1. Availability of the programme materials, aids and equipment and a clear programme implementation plan.
2. Availability of school equipment, materials and necessary facilities.
3. Readiness and willingness of teachers or instructors involved.
4. Willingness and co-operation from administrators concerned,
5. Readiness of the target subjects.

Details of such programme implementation and experiments will be presented in chapters 4, 5, 6, and 7, and in the next section.

3.4.9 EVALUATING THE TRAINING PROGRAMME AND MATERIALS

In the context of my training programme the last stage is
concerned with the evaluation of the training programme and materials.

The concept of evaluation in any context, I would suggest implies a checking or assessment of what goes on, in order that the actual facts of a situation may be ascertained and remedial action and decisions may be taken where necessary. When systems approach techniques are being used evaluation assumes even greater significance and becomes a very positive and necessary condition for the movement of the total system towards achieving its objectives.

As a first step in evaluation in the context of a total system it is necessary to identify the dependent (or sub-) systems in terms of their inputs, processes, outputs and functional relationships. These features of system and sub-system will be explained in more detail in the following sections.

a) General criteria for assessing achievement

In any system a number of general criteria may be identified as indicative of achievement of its broad objectives, before going into an analysis of its specific objectives and their achievements.

Three general criteria for assessing achievement are (Unesco, Bangkok, 1978):

i. **Effort** This comprises all supportive activities that must work in unison in order that the main activity may be successfully completed.

ii. **Effectiveness** This signifies the long term effect a programme is expected to have on the target population. In order to evaluate this aspect specific criteria of success need to be worked out.

iii. **Efficiency** This is considered as a major criterion in looking at possible alternative strategies for achieving the same objectives. More than one alternative may be considered in terms of the relative costs or the time involved.

b) **Goal-free evaluation** This concept is proposed by Scriven (1967, 1974). It might be in some instances that the evaluator or the programme designer does not confine himself to the stated objectives of a new product or procedure,
but rather seeks to assess and evaluate outcomes from any sources. This means that an evaluation undertakes to examine the effects of an educational innovation and to assess the worth of these effects.

c) Approaches to Evaluation Training programmes can be evaluated by two different approaches - external and internal, depending on particular purposes and situations. (Tracey, 1968)

i. External evaluation External criteria may be used to measure the results of training stages when students move on to the next stage. Typical benefits of this evaluation to the training might be:

1. Improvements or increases in:-
   - attitude toward the training system
   - training satisfaction
   - student skills
   - quality control, etc.

2. Reductions or decreases in:-
   - absenteeism
   - accident rates
   - student tension
   - spoilage of materials
   - machine, tool damage etc.

Information for this evaluation can be gathered in many forms such as observation, reports, interviews, questionnaires, etc.

ii. Internal evaluation This evaluation is carried out within the training stage, to determine programme effectiveness, efficiency and effort. Internal evaluation may take several different forms:

1. Participation measures This is a measurement of participants in terms of the number or percentage of students attending or completions for any given stage.

2. Comparison with norm This form of evaluation is
the comparison of the training programme with those offered by other methods or programmes of similar size and objectives.

3. **Comparision with a hypothetical concept of a 'quality' programme** In this instance, appraisal is based upon one person's notion of what a good programme should be. There is no general standard of quality against which any given programme can be compared.

4. **Measuring behavioural change** Measuring the amount and direction of behavioural change within the training programme. Here evaluation is directed toward the measurement of learning accomplished within a specified instructional situation.

5. **Participant reactions** This is measured by questionnaires or interviews either during or after the training. It is the most subjective type of measurement.

6. **Measurement against a specific standard** Although there are no general standards against which to measure the quality of training programmes, there have evolved through experience and experimentation certain specific standards relating to programmes, systems, instructional strategies, and the like which may serve as indicators of the quality of a programme.

7. **Experimental research** This kind of research aims to substitute evidence for opinion, to make a critical and objective inquiry, by getting quantifiable fact. It involves logical, systematic investigation, and thinking in order to find the best solution to a specific problem.

Some of these internal approaches were used in my evaluation which will be presented in chapters 4 to 9.
d) Types of tests There are two types of tests used in my research: criterion tests and achievement tests. The former is used in every post-test of the study units and the latter at the end of every training stage.

These tests are different in both their purposes and characteristics. A criterion test is used primarily to provide information describing the degree of competence obtained by a particular student, independent of any reference to performance of others. An achievement test, on the other hand, is used primarily to measure relative standings of all students, reference need not be made to criterion behaviour. Scores obtained from a criterion-referenced test tend to cluster in the upper region, whereas scores obtained from an achievement test tend to be normally distributed.

SECTION 2: DESIGN AND CONSTRUCTION OF SYSTEM

3.5 DESIGN AND CONSTRUCTION OF SYSTEM

The following will present details of the analysis, design and construction of the training system, materials and evaluation criteria in relation to principles described previously.

3.5.1 JOB ANALYSIS

All first year skilled worker students at the Institute are given the same project exercise - production of a small vice (see Appendix A1). This project as analysed in relation to sequence of operations (details are described in section 3.1), reveals 13 production processes as shown in Appendix A2.

2.5.2 TASK ANALYSIS

By using a systems-thinking technique (described in section 3.2.1), each production process (e.g., filing, sawing, etc.) is analysed in terms of the knowledge and skill components. Input information, of course, is taken from the exercise project (production of a small vice). Some examples of these analyses are given in Appendix A3. Notice that the sub-system called 'plan' and 'materials' are common tasks for every production process, and there are some elements of knowledge and
3.5.3 IDENTIFYING TRAINING NEEDS

In this stage the training needs required for the knowledge and skills mentioned above will be identified and isolated. The process of training needs identification involves (a) the merits of knowledge and skills found previously and (b) characteristics of incoming students.

a) The merits of the intended knowledge and skills This stage consists of:

1. Assigning a score from 1 to 5 to every item of knowledge or skill found previously, and
2. deciding whether each item is either accepted or omitted.

These procedures were carried out, in this case, as the basis upon my personal impressions and experiences.

An example of these procedures is given in Appendix A4.

b) Characteristics of incoming students This training course is provided for all secondary school leavers either from general or comprehensive school systems.

These school leavers both male and female are aged between 16 and 20 years of age. Those who are from comprehensive schools may have some background knowledge and skills related to the workshop training course; whereas those who are from general school may have none.

It is assumed in this case that they all have the common interest, to attend all courses provided by the Institute, including this one of workshop training. Further, they are docile and well disciplined students. Therefore, I anticipated that they are more or less stereo-typed, as far as their motivation, interests, and attitudes are concerned.

The training course to be designed must be suitable for these students from general school systems. Therefore, the required training needs are actually the same as what have been found previously.
c) **Training goals and training specification** The required knowledge and skills are, in this stage, expressed into general training goals and detailed training specification. Conditions and standards of the training are considered in accordance with the present system currently administered in the Institute and as given in project exercises.

The complete training goals and training specifications are given in Appendices A5 and A6 respectively.

### 3.5.4 SELECTING THE TRAINING PROGRAMME

Not all the training specification will be implemented in practice due to limitations and constraints as already mentioned in background information and in section 3.4.

All in all, I will choose some of the training specifications of the first half of the semester, for my training system. Some of production exercises I chose were from parts 5, 6 and 7 (see Appendix A1). In addition, I also chose three U-shaped filing exercises prior to the production exercises of a small vice. One example of the U-shaped filing exercises given in practice unit 1 (See Appendix B2). For workshop knowledge, there were 11 topics chosen as shown in the network diagram of the study unit stage which will be described later.

Individualized instruction will be used almost throughout my training system. When individualized instruction functions successfully, students gradually take on more of the roles traditionally assigned to the teacher eg., planning, inspecting, grading. The assignment of these tasks will be accomplished in systematic ways, see Diagram 3.5.

These additional tasks for job knowledge and production works are:

- Planning operation sheets
- Fault finding and remedial measures
- Quality checking and grading.

### 3.5.5 FORMULATING THE TRAINING PROGRAMME AND OBJECTIVES

By using a systems approach, three phases of skill learning, (i.e., cognitive, organizing, and automatic phase) are broken down into 4 successive stages. They were, then, linked in the following
sequence: study stage, practice stage, consolidating stage, and exercise stage.

a) Rationale for adding the consolidating stage The consolidating stage is inserted prior to the exercise stage, is based on the assumption that students might have possessed already sufficient job knowledge, measuring skills, production skills, and be familiarized with operation sheets. Hence, the provision of the consolidating stage should integrate that knowledge and skill experiences within the cognitive structure of the students. Thereby, the students will be able to take full responsibility of the entire production process (i.e., from planning, producing, and grading finished products) in the final stage of the training. This approach will lead students towards self-confidence.

b) Work distribution of student tasks The diagram below shows the distribution of student tasks in four successive stages: and by the end of the training stage, the student will be responsible for the entire production process himself.

<table>
<thead>
<tr>
<th>Task Stage</th>
<th>Job Knowledge</th>
<th>Planning</th>
<th>Producing</th>
<th>Diagnosing &amp; Remediying</th>
<th>Checking Workpieces</th>
<th>Grading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Study</td>
<td></td>
<td></td>
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<tr>
<td>2. Practice</td>
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<td></td>
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<tr>
<td>3. Consolidating</td>
<td></td>
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<td></td>
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<tr>
<td>4. Exercise</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Diagram 3.5 Work distribution of student’s tasks in the new workshop training system.
c) **Organization of Learning** A linear additive organization method is used in designing the new workshop training system. It consists of the stages represented thus:

![Diagram of stages]

i) **Study unit stage** In this stage students will be required to assimilate all job knowledge given in the course. The prime learning method will be independent learning (i.e., self-study with given programmed texts). In accordance with conditions of learning, 'concepts' will be retained efficiently with repetitive applications and concrete situations. It is also true that part-method training is superior to whole-training for skill learning at the early stage. Therefore, simple discrete production tasks such as: measuring, clamping, scribing etc., are incorporated to every study unit programmed text.

ii) **Practice unit stage** In this stage students practice simple production tasks. They will learn and gain more skills and experience in measuring, producing, fault finding etc., as well as becoming more familiarized with the operation sheets. To facilitate individual working a series of pictorial sequence of operations will be given in every programmed text. To enhance self-responsibility, students are introduced to quality checking and grading, so that immediate and constant rewards and reinforcements are given.

As knowledge is generally retained for only a short period, it would be undesirable to let this phenomenon flourish. Therefore,
students should be remotivated and recall to their previous knowledge and experience. One possibility of doing this is by asking students a series of questions in routine report written for every practice exercise.

iii) Consolidating unit stage To consolidate student's knowledge and experience, particularly on important issues like: production techniques, common faults in production, the quality of finished work, etc., a series of stimulus response pairs could be given.

As students already have some job knowledge and possess some workshop experience, it is therefore possible to arrange a series of quizzes without giving additional information.

To enhance student's motivation and to anchor his ideas, comparative events or work conditions of the same kind would best be achieved with pictorial illustrations and quizzes. Correct answers to the questions that follow immediately would reinforce student's feelings. And if the student could complete all quizzes successfully this will increase his morale and self-confidence. In the case of the student making mistakes, the correct answers provided would help clear up his misunderstanding and refresh his memory.

iv) Exercise unit stage At the beginning of the exercise unit stage students will learn more tasks and experiences. These will be a transition period in which the students need some advice from the teacher in planning.

To facilitate and guide student's thinking some form of information should be given. This can be accomplished by, for example, explaining about the functions, characteristics and highlights of crucial points of task to be done. A series of questions, which I will introduce, through which students would begin planning by themselves, would also be useful for them.

At this stage there should be no fault-finding guide given, but a comparative illustration of good and poor work should still be available for reference.

Again the students should be given a series of review questions on recent work. This will help stabilize their memory and understanding
d) **Topics and exercises of the training** As individualized instruction will be used principally in the training programme (some other methods would be introduced for comparative studies), two criteria are established for organizing the job knowledge topics and production exercises.

1) **Time** Each study programmed text should not be longer than a lesson of 60 minutes, as regards theory and in addition should not give more than 30 minutes of practical exercises. For the practice unit and the exercise unit stage, the time used will vary depending upon contents contained in each exercise. But it should not be longer than 12 hours for practice units, and 24 hours for exercise unit. This parameter is based upon my personal impression for filing works, rather than upon any specific research findings.

2) **Contents** The contents for workshop knowledge will be organized on the basis of:

   i. **The production process** eg., filing, sawing, etc.

   ii. **The steps in the production process** If a particular topic is very long (longer than 60 minutes), it will be broken down into smaller units like filing I, and filing II, etc.

For workshop production exercises, each particular unit programme will be organized in terms of:

iii. **Types of work** This can be categorized into hand-tool works, advanced handtool works, machine works, and assembly works.

iv. **Production process** This is broken down by types of work into production processes such as filing, sawing, drilling, etc.

v. **Steps in the operation** The production process is reduced into production steps such as rough filing, smooth filing, curve filing, etc.
Based upon these criteria a number of topics and exercises are organized. They are given in the form of network diagrams as will be discussed in the next section.

e) Levels of mastery learning It is worth bearing in mind a number of constraints which pose a constant threat to the successful performance of students. Students are generally unfamiliar with other types of learning methods apart from lectures, 'talk and chalk', and dictation. Books and other resources are very rare. Students are mostly in the habit of listening to lectures rather than self-study.

Furthermore, all my learning materials had not been undergone through any pilot testing. They are original proto-types. Usually, programmed learning materials will be tested, revised and retested many times before they are finally put into operation. In that case a standard of 90/90 mastery level is quite probable for cognitive knowledge.

In my case, though, I would be happy if 90 per cent of students would achieve a score of over 60% in the post-test on every study unit of the programmed text. For production exercises, due to the fact that skills are in constant progress, there will be no predetermined level of mastery specified. This is a goal-free criterion. However, standards given in every drawing of each exercise will be of themselves a criterion for overall achievement by students, as there is a tolerance limit for every dimensional accuracy.

A complete list of terminal objectives of each training stage is given in Appendices A7 - A10. Notice that objectives in the study unit stage do not cover technical drawing and those in the practice unit and the exercise unit stage cover only the exercises I have chosen.

3.5.6 SEQUENCING LEARNING AND TRAINING PROGRAMME

By using the technique of network diagrams, all topics and exercises in four successive stages of the new workshop training system are drawn as shown in Appendix A11.

The principles and procedures of network diagrams are explained in section 3.6.
3.5.7 DESIGNING AND SELECTING LEARNING MATERIALS AND MEDIA

In relation to the design parameters mentioned earlier in section 3.7, the prime learning materials are prepared on printed texts. This will enable students to use them in the workshop as well as at home. Other media such as slides or 8mm. films are not suitable to use in the workshop, primarily because of dirt, grease and the limited amount of equipment available.

a) The Framework of Learning Materials. Based on the principle of a four stage learning sequence (MIAP) as already explained in section 3.7(b), the following information, tasks and activities are assigned for students in every stage of the new workshop training system.

i. Study unit programmed texts. These include the following:

1. Motivation
   -Introduction to activities and contents.
   -Objectives stated in behavioural terms.
   -Guide to study suggesting steps in learning and using the programmed materials.
   -Learning aids providing a list of necessary mediating as well as criterion aids.
   -Pretest to arouse student motivation and guide to appropriate sections of the main text.

2. Information
   -Main texts arranged in pictorial narrative form, each phase contains information of not more than two pages.

3. Application
   -Exercises given in relation to a particular text and containing
not more than five repetitive and/or applied questions.
Practical exercises are given at the end of the unit.

4. Progress
   -Solutions giving correct answers and sometimes incorrect answers as well.
   -Post-test being equivalent to the pre-test. This provides an indication of successful learning.

A complete example of the study unit programmed text is given in Appendix B1.

ii. Practice unit programmed materials This includes the following:

1. Motivation
to activities and factors for successful performance including both process and product.
   -Introduction

2. Information
giving an isometric view or sometimes a projection view.
   -A drawing
   -Activities informing a student of the tasks in the unit.
   -Question guide leading student thinking towards planning.
   -Pictorial sequence of operations providing a step by step detail of operations and tools used.
   -Faults and corrective measures providing a guide to common faults, causes, preventative and remedial measures.
3. **Application**
   - *Practice* where the student performs his production works.
   - *Report* giving as an enrichment task, to foster memory recall and understanding of workshop knowledge.

4. **Progress**
   - *Hints to quality measurement* providing both good and poor qualities of the work to be produced.
   - *Grading sheet* providing a list for checking, measuring and grading the quality of finished work.

A complete example of the practice unit programmed material is given in Appendix B2.

iii. **Consolidating unit programmed quizzes** These include the following:

1. **Motivation**
   - *Introduction* to the contents and factors affecting successful learning
   - *Objectives* describing successful achievement.
   - *Suggestion to use* indicating the steps in learning.

2. **Information/Application**
   - *Pictorial quizzes*

3. **Progress**
   - *Solutions* giving correct answers and sometimes incorrect answers.

A complete example of the consolidating unit is given in Appendix B3.
iv. **Exercise unit programmed materials** This contains less information than in the practice unit programmed materials. The sections contained in the material have the titles:

1. **Motivation**
   - Introduction providing ideas of the characteristics of skilled operators and student tasks in the unit.
   - Exercise guide providing suggestions for working.
   - Objectives providing a list of working processes and expected product outcomes.

2. **Information**
   - 'Your work' providing information about the features and functions and highlighting the crucial parts of the work to be produced.
   - A drawing given in projection view together with a list of necessary activities.

3. **Application**
   - Practice where a student performs all tasks required in the entire production process.
   - Report of the same type as that in the practice unit.

4. **Progress**
   - Grading sheet providing both conditions of both good and poor work, and a checklist for measuring, and grading finished work.

A complete example of the exercise unit programmed material is given in Appendix B4.
b) General Features of the new workshop training system

Thus far, all frameworks and formats of learning materials of my training system have been presented. The overall features of the new workshop training system will be described as follows:

i) Study unit stage  Every student has a free choice to select his own learning route in relation to the given network diagram. He can study programmed texts at any time, in any place, with any style he wishes. The programmed text is designed for self-study and self-pacing.

ii) Practice unit stage  Every student is required to complete all study unit programmed texts prior to the practice unit stage. Students will enter into this stage at different times depending on their previous progress rate. In this stage, each student will complete all given exercises individually. He can select exercises in relation to the given network diagram. Every student will measure his works and award grades to himself but the teacher must approve them each time. Students can ask for teacher help at anytime.

Every student must try his best to achieve all standards specified in the drawings, and meet the given pre-determined target production times. There is a score on this point as well as others (see Assessment form given in Appendix C9).

Students are allowed to work during breaks or in overtime and have freedom to take a rest at anytime.

iii) Consolidating unit stage  A student goes on to the consolidating unit stage when he has completed all exercises in the practice unit stage. He can select any programmed quiz in accordance with the given network diagram. He has complete freedom to choose his own study times, places and learning styles.

iv) Exercise unit stage  This is the same as that in the practice unit stage, as far as freedom to work is concerned. Here, a student will need to plan his own production-plan either individually or co-operatively with friends.

3.5.8 TESTING THE TRAINING PROGRAMME AND MATERIALS

As the new workshop training system will be tested in the
field, a few general features of the system will be different from its original process. This is due to tests and a series of experiments to be carried out during field study. For example, students may be asked to group for learning experiments or be interrupted for tests.

The diagram shown below is a general sequence of implementation plan.

1 = Orientation to students

2 = Pre-system tests

3 = Study unit stage & experiments

4 = Post-test 1

5 = Practice unit stage

6 = Consolidating unit stage

7 = Post-test 2

8 = Exercise unit stage

9 = Post-test 3

10 = Traditional system in operation

11 = Post-test 4
3.5.9 EVALUATING THE TRAINING PROGRAMME AND MATERIALS

Evaluation is the process of delineating, obtaining, and providing useful information for judging decision alternatives (Stufflebeam et al., 1972). The evaluation process, in fact, starts in the design phase before programme implementation. But the actual evaluating is just a small part of the measurement and evaluation process, taken place after the gathering of all the information has been completed.

a) What is to be evaluated? As my training system is, in fact, rooted in problems that exist in the present traditional training, as mentioned in problem analysis. The design and construction of my training system and materials take these problems into consideration throughout. It is expected that my training system will be capable of solving the problems. Therefore, part of the evaluation policy is to determine the merits of my training system and contribute to the workshop.

Another policy of the evaluation is to determine the extent to which my training system will achieve the training goals and learning objectives specified in successive training stages and in the training specification.

The evaluation scheme for this contribution to the present workshop problems is shown in table 3.1. It relates the specified present problems to possible solutions/treatments, and gives evaluation methods, measurement procedures, judgement and criteria, and timetable for measurement or information gathering.

The evaluation scheme for learning outcomes is presented in similar fashion, shown in table 3.2.
Table 3.1  Scheme for evaluation of the contribution to organization problems.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Inexperienced students in study skills.</td>
<td>Introduction to the different learning methods.</td>
<td>Comparative study into different learning methods (i.e. lecture v.s self-study, commercial texts with solution given v.s texts without solution) by two experimental group research designs.</td>
<td>Pre-test, post-test and study time.</td>
<td>Comparative effectiveness and efficiency.</td>
<td>In study unit stage.</td>
</tr>
<tr>
<td>b) Poor classroom conditions in workshop.</td>
<td>Freedom of place of study.</td>
<td>Students' reaction to choice of study places</td>
<td>Questionnaire.</td>
<td>Positive reaction in favour to choice of freedom.</td>
<td>Pre-system, post-study unit stage post course.</td>
</tr>
<tr>
<td>c) Project exercises too large.</td>
<td>Freedom of overtime working and choice of working time</td>
<td>Students' reaction to choice of overtime working and working time.</td>
<td>Questionnaire.</td>
<td>Goal free</td>
<td>Post-course.</td>
</tr>
<tr>
<td>e) Unmatched timetable between workshop training and classroom teaching.</td>
<td>Self-study in study unit stage prior practice and exercise unit stage.</td>
<td>Study of knowledge and skill development in successive training stages and correlational study of factors affecting skill attainment.</td>
<td>Achievement test on workshop knowledge and performance test on knowledge skills.</td>
<td>Significant gain and positive progress.</td>
<td>Pre-system, Post-study unit stage. Post consolidating unit stage. Post-exercise unit stage.</td>
</tr>
</tbody>
</table>
Table 3.1 (contd.)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>f) Lack of systematic training.</td>
<td>New system of training.</td>
<td>-same as (e)</td>
<td>-same as (e)</td>
<td>-same as (e)</td>
<td>-same as (e) -Post-exercise unit stage. -Post-course.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Students' reaction to system, activities and materials.</td>
<td>-Questionnaire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Lack of systematic guidance and supervision.</td>
<td>Continuous feedback and self-evaluation.</td>
<td>-same as (d)</td>
<td>-same as (d)</td>
<td>-same as (d)</td>
<td>-same as (d) -same as (f) -same as (f)</td>
</tr>
<tr>
<td>h) Insufficient teaching method.</td>
<td>Short course/seminar</td>
<td>-same as (f)</td>
<td>-same as (f)</td>
<td>-same as (f)</td>
<td>-same as (f)</td>
</tr>
<tr>
<td>i) Over strict rules and regulations.</td>
<td>-discussion with administrators. -Introduction to the new training system.</td>
<td>Teachers' reaction to the new training system</td>
<td>Informal interview.</td>
<td>Goal free</td>
<td>Post-exercise unit stage.</td>
</tr>
<tr>
<td>1. Area</td>
<td>1. Workshop knowledge and skills as specified in training specification and successive training stages.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>---------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 2. Evaluation | 1. External validation using previous student norm.  
2. Internal variation for instructional materials.  
3. Development of student knowledge and skills. |
2. Criterion referenced test for internal variation.  
3. Performance tests for skill development. |
2. Significant gain scores for internal variation.  
3. Goal free for skill development |
| 5. When? | 1. Presystem, post-study unit stage, post-consolidating unit stage, post-exercise unit stage, and post-course.  
2. Pre-test, post-test, and retention test at post-exercise unit stage.  
3. Pre-system stage, post-study unit stage, and post-exercise unit stage. |

Table 3.2 Evaluation scheme for learning outcomes.
b) Tests and Measuring Instruments  The evaluation mentioned above is the framework for designing tests and other measuring instruments. They can be categorized into knowledge, skills and perception.

1. Knowledge  Two sets of paper and pencil tests are constructed: achievement tests and criterion-referenced tests.

i) Achievement tests  Two tests are constructed in relation to the training specification. They are tests of benchwork theory and technical drawing. The purpose of both tests is the external validation of the new training system. Some previous first year skilled worker students will be used for establishing standard referenced norms. Tables of specifications of both tests are given in Appendices C1, C2, showing the contents of the topics covered in the tests, the number of test items and their estimated level of taxonomy. The complete examples of both tests are given in Appendices C3 and C4.

ii) Criterion-referenced tests  A collection of post-tests from 11 topics of study unit programmed texts is used for internal validation of the study unit stage. These tests are constructed based on their enabling objectives.

They are different from the achievement tests, mentioned above, in two main aspects. Firstly, the contents of these tests are directly related to the stated learning objectives of the programmed texts. Secondly, item difficulty of each test item is dependent upon the complexity of the topics. In contrast, the achievement tests are samples of training specification, and their item difficulties vary from easy to difficult in order to obtain a wide range of score distribution across students.

The collection of criterion-referenced tests is not used for external validation of the training system. In the first place this is due to the threat of a coaching effect that exists in students of this new training system as these students will be attending lectures or studying the programmed texts. Another reason is the limited number of topics provided in the study unit stage which does not include any topics on technical drawing. After all, these criterion tests are used only for the study unit stage whereas the achievement tests are used for the whole new training system.
The complete example of the collection of criterion tests are given in Appendix C5.

2. **Skills**  Skill learning, unlike cognitive knowledge is subjected to constant progress development. It is unjustifiable and impracticable to test new students with the test used for expert operators.

   In order to evaluate the effectiveness of training stages, tests on skill development need to be designed and constructed. Three different skill tests are constructed in my research. They are administered at the pre-system stage, post-study unit stage, and post-exercise unit stage. There will be no time available to test students at the end of the course, and it is beyond the scope of my training system.

   The contents of the tests are not only affected by the nature of skill development, but also the process of production, time, cost, available staff and equipment and facilities. These factors affect test procedures. For example, a number of testing stations of fundamental skills such as filing, sawing, etc., are designed for the pre-system stage (see an example in Appendix C6), and one exercise of the project is selected for the post-exercise unit stage test (see Appendix C8). The test sheet used at the post-study unit stage is given in Appendix C7.

   As there will be no previous first year skilled worker students exactly appropriate for establishing standard referenced norms at different training stages, together with progressive development of student skill; the criterion for judgement of effective training is therefore open for subjective assessment.

3. **Perception**  There are a number of types of overt and covert behaviour in students which cannot be measured in quantitative terms. Most of these are concerned with perception of activities, components and relations which characterize the features of programmed materials, new and traditional training systems. Much of this information points to the contribution made towards current workshop problems.

   The prime method used in gathering the information is by means of questionnaires. There are six questionnaires, one student evaluation sheet and two interviews for workshop teachers, designed and planned for the evaluation.
i) **Student evaluation sheet.** This evaluation sheet is used for students to judge their perception of the components of a study unit programmed text. The result will be used for improving quality of the particular programmed text. Details of the rationale, the instrument used, the results and discussions are presented in section 4.5.

ii) **Student attitude questionnaire at the pre-system stage.** This questionnaire is used for the incoming students. It is meant to survey the students' previous workshop experiences, expectations of the new course and the reactions to the new system. The result will provide descriptive information about the working atmosphere in the previous workshop, the entry attitudes of students towards course arrangements and principles of the new training. Details of the rationale, the instrument used, results and discussion are presented in sections 7.5, 7.6.1, and 7.8.1

iii) **Student attitude at the post-study stage.** This questionnaire is meant to describe the current standing of students' attitude and reaction activities and features of study unit and individualized instruction. Thus later improvements or modifications can be made for future students.

iv) **Student perception into activities and components of the new training system.** This questionnaire is meant to determine areas of strength and weakness in the activities and components provided in various stages of the new training system. The results will be used for improving and modifying the overall activities and components of the materials and the system itself. This questionnaire will be used at the end of the exercise unit stage.

v) **Students' attitudes towards the new and traditional training systems.** This questionnaire is designed for the incoming students at the end of the course. By that time the students will have gained experiences of both the new and the traditional training system. Therefore, the comparative study of the merits of activities and features of both the new and the traditional training system can be accomplished. The results will give general descriptive
information for part of the conclusion and further insight into the new approach of training system.

vi) **Student survey into teacher involvement.** There are two separate questionnaires used for both the previous first year skilled worker students and the new incoming students. Both questionnaires will survey general involvement of the workshop teachers at various stages of the training of both the new and traditional training systems. The results will give descriptive information for comparison of teacher involvement in both training systems. Therefore, a conclusion and further outlook into the new approach of training system can be proposed. Details of the rationale, results and discussions are presented in sections 7.5.5 and 7.8.5.

vii) **Interview for workshop teachers.** By the end of the new training system the workshop teachers who implement the system will be interviewed informally. The results will provide additional information to the modification of the new training system. Results from the teacher interviews are presented in section
4.1  INTRODUCTION

According to my approach to the practical course of workshop training in Benchwork skills, the study unit stage was the first of four training stages: study unit stage, practice unit stage, consolidating unit stage and exercise unit stage. The study unit stage has a dual function: to provide fundamental workshop knowledge, and to provide preliminary benchwork skills. Students would thus be ready for the next training stage.

In order to fulfill its functions, the study unit stage was constructed to contain 11 topics (see network diagrams, Appendix All). Each topic would provide both knowledge and practical skills related to the requirements of later training.

Programmed texts of my own design were constructed for self-study, covering both knowledge and practical skills. They were designed in such a way as to contain the study unit and learning aids, and could be used in a classroom, at home or elsewhere. Self-study was absolutely new for the students. In the past they were taught by the lecture method only. It was thus necessary both to change their attitude to this new learning method and training system, and to develop their knowledge and workshop skills. Furthermore, they were introduced to study with commercially available texts as part of the research towards independent study.

4.2  EVALUATION

Taking a broad view of the elements of the study unit stage, a number of evaluations could be carried out on the performance of students and procedures. These would include the achievement of objectives and the effectiveness and efficiency of teaching, materials, and action taken\(^1\). Some of these evaluations on a number of topics

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will be discussed in this chapter. They are as follows:

1. Effectiveness and efficiency of lecture and self-study with my programmed texts and commercial extracts,
2. Student performance on preliminary benchwork skills, and
3. Other qualities of a programmed text.

Other evaluations such as development of knowledge, skills and attitudes will be discussed later in separate chapters.

SECTION I

4.3 EFFECTIVENESS OF TEACHING-LEARNING METHODS

4.3.1. EXPERIMENTAL CONDITIONS

There were only four topics implemented under experimental conditions. The rest were either taught by myself in a classroom or studied by the students themselves at home or elsewhere, and these results will be discussed in the next chapter.

The four experiments into the effectiveness of teaching-learning methods were as follows:

1. Techniques of filing flat work.
2. Dial indicators.
3. Use of the chisel and chiselling.
4. Use of the saw and sawing.

The first two topics were compared teaching-learning by lecture with self-study using my programmed texts. The second two compared students' learning from commercial texts where solutions were given to exercises, on the one hand and where no solutions were given to exercises on the other.

Each experiment was carried out in two classes, each consisting of a combination of CC and ACC students. The students were divided into four small groups according to height and combined together into two mixed classes. They were then randomly assigned to experimental groups.

During experiments the following conditions were maintained:

1. Students were asked to refrain from cheating. They were assured that results of the experiment would not effect their final qualifications. In order to discourage cheating I also carried out normal examination invigilation
as did the teacher in the other class.

2. The contents of a lesson, the exercise and solutions from my lecture were the same as those in the programmed text, i.e., they were the same for the two classes in every experiment.

3. A lecture was given according to a lesson plan (see Appendix B11) constructed in the same way as in the programmed text.

4. The same sort of teaching-learning aids were used in both experimental classes.

5. Two adjacent classrooms with the same conditions and facilities were used.

6. Both groups were started at the same time.

7. Solutions to the post test were only given after the experiment.

4.3.2. ANALYSIS

There were two main considerations in each experiment; the effectiveness of the teaching-learning methods in terms of average achievement of students and the efficiency in terms of time used.

A student scores and learning time were on an interval scale, the standard t-test was used to test for statistically significant differences.

4.3.3. RESULTS

a) Techniques in filing flat work

An experiment on techniques in filing flat work studied the relative effectiveness of lecture and self-study methods. It was hypothesized that the achievement of students in the self-study group would be as high as that of students in the lecture group, and learning time taken by the self-study group would be similar to that of the lecture group.

There were 3 performance objectives in this topic, including one for motor skills. This however was excluded during the experiment. The pretest consisted of five objective test items and seven objective test items formed the post test. An example of a
The reliability coefficient of the post-test was negative as computed with the Kuder-Richardson formula $21(KR21)^1$, (virtually the same result was found with $KR\ 20$). This result will be discussed later under 'Factors affecting test reliability' in this section.

The lecture group contained 17 students (two students absent) and the self-study group 18, (one student absent). Students in the lecture group were taught by myself. During the lecture they received information, answered some questions and completed exercises prior to checking for correct answers. The self-study group was supervised by a workshop teacher. They proceeded through the programmed text in accordance with the given instructions which were the same as those in the lecture. However the students studied by themselves and progressed at their own pace. Prior to the experiment both classes had the pre-test administered to them and similarly the post-test at the end. The results of the pre-test and the post-test for both classes are given in Table 4.1.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pre-test</th>
<th></th>
<th>Post-test</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\bar{X}$</td>
<td>S.D</td>
<td>$t$</td>
<td>$\bar{X}$</td>
</tr>
<tr>
<td>Lecture</td>
<td>17</td>
<td>2.5</td>
<td>1.1</td>
<td>-0.4</td>
<td>7.9</td>
</tr>
<tr>
<td>Self-study</td>
<td>18</td>
<td>2.7</td>
<td>1.0</td>
<td></td>
<td>7.2</td>
</tr>
</tbody>
</table>

Table 4.1 Test results of the lecture and self-study groups for both pre-test and post-test, on techniques in filing flat work.

1. $r_{xx} = \frac{n}{n-1} \left[ 1 - \frac{\bar{X} (n - \bar{X})}{n \times S.D^2} \right]$, where $n = 9$, $\bar{X} = 7.3$ and $S.D = 1.0$
The pre-test results indicated that self-study group performed slightly better than the lecture group, but there was no statistically significant difference between the mean scores of both groups. This implied that both groups had the same initial knowledge in techniques of fling flat work. In the post-test, the lecture group performed slightly better than the self-study group. There was no statistically significant difference between mean scores of both classes, however, this implied that both groups had achieved at the same level. Since both groups studied the same piece of information and completed the same exercises, the results on the post-test implied that CC and ACC students in the self-study group could study my programmed text as successfully as those CC and ACC students in the lecture group. Consequently it implied that the self-study method was as effective as the lecture method.

As regards the time spent studying by both classes, it was found that average study time for the self-study group was 50.6 minutes which was less than the 60 minutes of a lecture. The maximum and minimum time spent with the self-study group were 60 minutes and 25 minutes. This result was unusual, negatively skewed. Investigation of student responses in the post-test and exercises revealed the following:

1. There were two students who took the minimum study time and did not complete any exercises at all; their post-test scores were 6 and 7, i.e., below the average score for their group.

2. There were two students whose study time were 50 and 60 minutes. Both of these students completed all exercises with a high error rate, five mistakes (42%) and seven mistakes (58%) respectively. But their post-test scores were extremely high, i.e., 9 (100%) and 8 (89%) respectively.

The investigation gave further indication that the average score for the self-study group would have been slightly improved if the students had completed all exercises, and average study time for the self-study group should have increased a little. In this respect the efficiency in terms of time of each methods were very similar.
b) **Dial indicators**

The second experiment was on dial indicators, repeating exactly in the same way as the previous one. But students who previously attended the lecture now studied with the self-study method, and the self-study group attended the lecture.

There were three learning objectives, none of which was for motor skills. The pre-test and post-test were in equivalent forms each containing five objective items. The reliability coefficient of the post-test was 0.5 as computed with the KR20 formula\(^1\), and the standard error of measurement was 0.7.

The lecture and self-study groups contained 18 students each (one student was absent in each group). The mean pre-test score of the lecture group significantly was larger statistically than that of the self-study group, at \( p < 0.05 \), as shown in the first column of Table 4.2.

An analysis of covariance was used to adjust the mean post-test scores of both groups for initial differences in their pre-test scores. The adjusted mean post-test scores are shown in the third column of the table. The complete details of covariance analysis are provided in Appendix D1.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Adjusted Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( \bar{X} )</td>
<td>S.D</td>
<td>t</td>
</tr>
<tr>
<td>Lecture</td>
<td>18</td>
<td>3.1 1.6</td>
<td>5.4 0.7</td>
<td>5.3 0.2</td>
</tr>
<tr>
<td>Self-study</td>
<td>18</td>
<td>2.0 1.3</td>
<td>2.3</td>
<td>0.9</td>
</tr>
</tbody>
</table>

\( * \) \( p < 0.05 \)

Table 4.2 Test results of the lecture and self-study groups, showing pre-test, post-test and adjusted post-test scores for Dial Indicators.

1. \( r_{xx} = \frac{n}{n-1} \left[ 1 - \frac{\Sigma pq}{S.D^2} \right] \) where \( n = 6, \Sigma pq = 0.56, \) and \( S.D = 0.95 \)
Although the mean post-test score of the lecture group was larger than that of the self-study group, the differences were not statistically significant, at $\alpha = 0.05$ for both the original and the adjusted mean post-test scores.

The results shown above indicated that students from the self-study group performed as well as the lecture group on the post-test. This implied that students in the self-study group using the programmed text on Dial indicator were as successful as students who attended a traditional lecture. This implies that the self-study method was as effective as the lecture method, as far as learning contents, exercises and the structure of my programmed text were concerned.

The average study time used by the self-study group, on the other hand, was 40 minutes, which was less than the 50 minutes of a lecture. The maximum study time used in self-study was 58 minutes the minimum was 30 minutes. This indicated that students were likely to study on their own faster than when attending a lecture. This could be explained as due to the following factors:

1. In a lecture some amount of time is wasted during question periods.
2. Since a lecture is a group-based instruction method, a class will progress as fast as the average of the slow learners, unless the teacher ignores them.
3. In self-study even a slow learner seems to read faster than the teacher's speech and explanation or writing on the blackboard.

The results in this experiment corresponded to those in the previous experiment, both in terms of achievement and study time. These consistent results confirmed the findings that both CC and ACC students were as capable of studying successfully on their own with my programmed texts as by attending lectures. Furthermore, many students could complete their programmed texts faster than other students in lectures. These findings, therefore, provide evidence for teachers, and administrators, as well as the students concerned of a new learning method by which a student himself can progress at his own pace and learn successfully.
c. Use of the chisel and chiselling

The experiment on the use of the chisel and chiselling was a study of the self-study method using commercial texts but comparing two different learning conditions: exercises with solutions given, exercises with no solutions given. The commercial extracts, in this case came from two German books in their versions which had information related to specified learning objectives. The two books were:

1. Erich Wieczorex and Hugo Leben 'Metal Trade Principles', translated by Phairoj Pongphipat; Ernst Klett, Stuttgart.

Both extracts contained a wide range of factual knowledge about names, definitions, principles and rules, which require a varying degree of memory as well as intellectual skills (Gauge & Briggs, 1974, pp.23-24). They also included a number of illustrations which facilitated student learning and communication. One contained information with a practical orientation and the other with a theoretical one. In order to make a student learn meaningfully, a list of objectives and a number of exercises were also incorporated see Appendix B6.

CC and ACC students were mixed together and divided into two groups. I supervised the 'solutions given to exercises' group and a workshop teacher the 'solutions not given to exercises' group. There were four cognitive learning objectives on the chisel and chiselling. Both the pre-test and post-test contained 9 objective test items (12 dichotomised responses), for an example see Appendix B6. The reliability coefficient of the post-test was 0.3 as computed with KR20 formula, and standard error of measurement was 1.5. Reasons for the low reliability coefficient of tests will be discussed later in this section under 'Factors affecting test reliability'.

Both the 'solutions given' and the 'solutions not given' groups contained 19 students, (there were no absentees). The 'solutions given' group performed better than the 'solutions not given' group on the pre-test. Conversely, the 'solutions not given' group performed better in the post-test. However, there were no statistically
significant differences between the mean scores of the two groups on both tests, with $\alpha = 0.05$, as shown in table 4.3.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\bar{X}$</td>
<td>S.D</td>
</tr>
<tr>
<td>Solutions given</td>
<td>19</td>
<td>3.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Solutions not given</td>
<td>19</td>
<td>3.5</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Table 4.3 Test results for the 'solutions given' and the 'solutions not given' groups in the pre-test and post-test, in use of the chisel and chiselling.

Results above indicated that both groups had almost the same level of initial knowledge of the use of the chisel and chiselling. After the completion of the study they had both increased this knowledge by an equal amount. This implied that the self-study method with 'solutions not given' was just as effective as with 'solutions given' to exercises.

The average study time used for the solutions given group was 42.5 minutes (S.D= 7.84) which was less than the 55.4 minutes (S.D= 5.98) of the 'solutions not given' group. The difference in average study time between the two groups was less than 1 S.D, which indicated no statistically significant difference.

This implied that the study time used in self-study with 'solutions not given' was close to that used in self-study with 'solutions given' to exercises.

The reasons for the lack of statistically significant difference in these two learning situations as regards average achievement and study time are as follows:

1. In both learning situations the body of information
in the text, as well as the learning mode, was identical.

Thus, for a student in either class there was the same opportunity that learning would take place while he was encountering (i.e., reading, considering, remembering) the information; even though successful learning was not yet confirmed.

2. Exercises in the text were the same for both classes. That meant a student in either class had the same opportunity to repeat and strengthen his learned knowledge to some extent, depending on the capacity of his intellectual skills.

3. Solutions to correct answers were theoretically a means of reinforcement and motivation for further learning. The absence of solutions in one group did not mean that a student failed to get feedback. He could still obtain it, if he needed to, either by looking up the text or asking friends. He would thus receive reinforcement and satisfaction if correct answers were found, and if misunderstandings would be adjusted and corrected when any mistake was identified or reported.

4. It was probably the case that a student in the 'solutions not given' group was more conscious in his study than one in the 'solutions given' group. Because he was aware of the present situation, he studied the text more carefully than usual. This phenomenon is known as frustrative non-reward. Its effect can be seen in Table 4.3 where the gain score of the 'solutions not given' group was higher than that of the 'solutions given' group.

d) Use of the saw and sawing

Another experiment on self-study with solutions given and solutions not given to exercises with commercial extracts were on


98
the use of the saw and sawing. Learning situations were kept the same as in the previous experiment, except that the two groups of students were now switched over to different learning situations. I supervised the 'solutions given' group and a workshop teacher the 'solutions not given' group.

There were four learning objectives. Both the pre-test and post-test contained 17 objective test items. Examples of the learning objectives and the test are given in Appendices B5 and C5. The reliability of the post-test was 0.7 and the standard error of measurement was 1.6 as computed with KR20 formula.

The 'solutions given' group and the 'solutions not given' group each contained 19 students (no student was absent). The first group performed worse on the pre-test but better on the post-test compared to the second. However, there were no statistically significant differences between mean scores of both groups on both tests, as shown in Table 4.4.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X  S.D  t</td>
<td>X  S.D  t</td>
</tr>
<tr>
<td>Solutions given</td>
<td>19</td>
<td>4.5 1.2 0.6</td>
<td>6.9 1.6 -0.8</td>
</tr>
<tr>
<td>Solutions not given</td>
<td>19</td>
<td>4.3 1.7</td>
<td>7.4 2.0</td>
</tr>
</tbody>
</table>

Table 4.4 Test results for the 'solutions given' and the 'solutions not given' groups in the pre-test and post-test, in use of the saw and sawing.

The average study time used in the 'solutions given' group was 51.7 minutes (S.D= 9.39) which was almost identical to the 51.8 minutes (S.D= 10.38) of the 'solutions not given' group. Therefore, the groups did not exhibit statistically significant differences in study time.

The results above indicated that both groups had the same level of initial knowledge of saws and sawing and that their knowledge increased to the same extent after completing their study. This implied that self-study with the 'solutions not given' to
exercises in commercial extracts was as effective as self-study with 'solutions given' to exercises. It was also true that both learning situations were as efficient as each other, as far as CC and ACC students, and as regards the difficulty level in commercial extracts. The reasons for the lack of statistically significant differences between the learning situations have already been discussed in the previous experiment.

The results found in this experiment corresponded to those in the previous experiment, in terms of both achievement and study time. These findings gave strong support for a move towards independent study of commercial publications. From the findings it was quite certain that the first-year skilled worker students were capable of studying on their own with commercial extracts, provided that minimum elements of meaningful learning (Klausmeier & Ripple, 1971, P.70) were met, i.e., learning objectives, a guide to learning, a body of knowledge and exercises. It would, however, be of benefit to students if a teacher would provide elements of evaluation for them by solution sheets, small group discussions etcetera.

4.3.4 FACTORS AFFECTING TEST RELIABILITY

Results on reliability coefficients in some tests discussed earlier were low and sometimes negative. This could be explained as due to the following:

1. The number of test items was too small in relation to the number of students, and the range of score distribution was thus limited. Adding more items would increase the reliability of the test, provided that they are equally reliable (Brown, 1976, p.76).

2. Difficulty level of test items (Mehrens & Lehmann, 1973, p.117). As test items in this case were constructed based on the assumption of level of achievement rather than degree of achievement (i.e., criterion-referenced test rather than norm-referenced test), their discrimination power to produce a wide range of score distribution was very limited.

3. The present classical reliability formula is not quite appropriate for criterion-referenced test (Mehrens & Lehmann, 1973, p.121). Since classical reliability
depends upon the existence of differences among students' observed scores, the reliability of such a criterion-referenced test would be undefined. A reliability of criterion-referenced test as mentioned by Morris & Fitz-Gibbon (1978, p.111) would require a correlation of the pass-fail pattern on two administrations. It was not possible to arrange for this in my study.

4.3.5 SUMMARY OF FINDINGS

In this section four experiments were carried out in two areas of teaching-learning methods: lecture and self-study. The first two experiments compared the effectiveness of a lecture with that of self-study with a programmed text of the researcher's own design. The second two experiments were in self-study methods with commercial extracts under two different learning conditions: solutions being provided for exercises and solutions not being provided for the exercises. All experiments were carried out with two groups of mixed CC and ACC students in the second semester of the benchwork skills practice course. Results from two identical experiments showed consistent findings as follows:

1. Students studying on their own using the self-study method with programmed texts designed by the researcher were as successful as students who attended lectures.

2. Students who studied with the researcher's programmed texts on average completed their studies faster than students who attended lectures.

3. With the provision of learning objectives and exercises for the commercial texts, students of both groups were capable of studying successfully on their own whether or not the solutions were given to these exercises. There was a precondition, however, that those commercial texts had to contain information related to the learning objectives and should not require study time greater than 60 minutes.

4. Study time used for the 'solutions not given' group was similar to that of the 'solutions given' group.
4.4 STUDENT PERFORMANCES ON PRELIMINARY BENCHWORK SKILLS

4.4.1 Overview

As mentioned earlier the study unit stage has functions to provide both workshop knowledge and preliminary benchwork skills. The practical exercises provided in some topics at this stage were aimed at acquainting students with the use of tools, the nature of the work and the control of movements of hands, arms, body and legs.

To facilitate student training each practical exercise was designed to meet the following parameters:

1. Small discrete elementary works such as clamping a piece of work in a vice, making a layout on a piece of steel, etc.
2. Provision of guides to activities and pictorial sequences of operations.
3. Provision of templates of finished works, hints on correct movements of tools, hands, etc., or correct results of measuring works.

Some topics, like measuring with a vernier caliper could be practiced at home or elsewhere. But many exercises such as marking a layout on a piece of steel with a vernier highgauge required tools equipment and materials available only in the workshop. This depended of course, on the nature of the work.

4.4.2 Procedures and Analysis

There were four exercises during which students were under the observation. Results from these observations will be presented in this section, but not for other exercises, with lack of reliable results due to students being allowed to complete them at home or in the workshop at other times.

1. A few topics had no practical exercises due to lack of tools and equipment such as dial indicators, and universal bevel protractors.
For exercises in layout work, observation was made at a distance of one group of eight ACC students. Product outcomes of these students as well as others at later time were ready for objective measurements with two transparent plastic templates as shown in the illustration below.

Illustration 4.1 Transparent plastic templates provided for checking correct results of students' work on layout exercises.

Exercises on sawing and chiselling were combined for observation purposes. Product outcomes were not ready for any measurement due to distortion which occurred on the works during student practice. Student performances, however, were judged as either right or wrong according to the observation checklist which was identical to that used in the pre-study unit stage test (see Appendix B8). The same procedure was applied to an exercise on filing as well.

Analysis of the results mentioned above was based on numbers of correct performances or correct measurements on finished work. More than 90% of students were expected to complete two exercises on layout work successfully. No specific criteria were given for the correct number of student performances on filing, sawing and chiselling. This was because it was expected that students at this stage would have many difficulties in performance on their first trial.
The following discusses the results of layout work, filing rough surfaces, and sawing and chiselling.

4.4.3 RESULTS

a) Layout work

Eight ACC students were asked to study the programmed text on layout work and return their completed work to me. Their performances were under my supervision at a distance of about three to eight metres. Students studied their programmed texts individually in the workshop and then proceeded to practice exercises (see Appendix B9).

It was found that five students followed the instructions given in the solution sheets (see Appendix B10) constantly, and three students worked using their understanding in the first place with later reference to the solution sheets. They checked their work using the plastic templates provided. All their finished work was complete and correct according to the plastic templates. The results of these exercises for other students later were also complete and correct.

The absolutely perfect outcomes on both exercises were above the pre-determined criterion. This could be explained as due to the following reasons:

1. Students could read a vernier scale perfectly accurately and no decimal readings were actually required.

2. The vernier highguages used were highly accurate instruments.

3. The skills required to handle and set up scales on a vernier highguage were simple and commonly needed in everyday life. This was also true for skills needed in holding a work piece.

4. The skills needed to use a steel rule and a divider were absolutely identical to those needed to use a normal ruler, pencil and compass which had already been mastered from earlier schooling.

5. Complicated operations and sequences were readily displayed or written in the solution sheets. A step-by-step working was the key to successful operations.
6. The drawings given both in the worksheet and on the plastic templates provided the students with concrete images of the completed work.

b) **Filing rough surfaces**

Referred to the first section of the experiment on techniques in filing flat work, both CC and ACC students now proceeded to practical exercise No. 4. on rough filing (see Appendix B1, shortly afterwards. This was their first practice in filing. All of them had already practiced clamping work in a vice, which is a prerequisite for filing.

Students of both classes were still grouped according to the previous experiment. I supervised the lecture group and two workshop teachers supervised the self-study group. Conditions for workshop practice in this case were the same for everyone, except they had to use their own files.

From our observations, no student made a mistake in clamping a workpiece in a vice, but three students from the lecture group and five students from the self-study group made mistakes in holding the handle of the file.

After they had been filing for 17 minutes, we realised that more than 50% of students of both groups had difficulty in controlling and regulating forces on a file and co-ordinating movements of hands, arms, body and legs. We eventually decided to interrupt their operations and I gave them an additional demonstration for about 15 minutes. We then helped them to correct their mistakes and guided them individually. Despite this five students still found it very difficult to co-ordinate their movements for a long time. However, they all continued their work until the end of the time allowed.

4.4.3.1 **DISCUSSION**

From the results above, three main points for discussion were distinguished: 1) no mistakes were made in clamping work, 2) some students did make mistakes in holding a file, 3) more than 50% of the students could not control and co-ordinate their movements correctly.
Successful performance on clamping work could be due to:
1. The fact that holding and positioning the work and turning the handle of a vice were simple operations related to everyday skills.
2. The condition of the students, who were still fresh from their early practice on this work, and knew very well where to position and how to clamp the work.
3. The work itself was of a very simple shape and demanded no complicated techniques.

Students' mistakes in holding the handle of a file were probably due to:
1. Discomfort in holding them according to the suggested method because it contradicted their normal habits, and in fact differed from the commonplace way of holding things of the same kind, such as a knife.
2. Pain in the palm of the hand resulting from pressure between the palm and the small end of the handle, and between the palm and rough cutting edges of the end of the file. Students therefore went back to holding it as they had before.

This mistake was common and not serious in students new to files and still unfamiliar with them. It would be a serious mistake for a teacher to ignore this point, however because students would then not learn correctly and acquire bad habits which would be difficult to correct later on. The teacher should therefore encourage his students and quickly correct their mistakes.

For the students who could not control and regulate their movements properly during filing, the most probable causes were:
1. The strong resistance of the work to filing, together with varying leverage distances between the forces on the left and the right hand, causing a deterioration of the balance and speed of hands, arms, legs and body movement.

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2. The discomfort and pain on the palms of both hands, caused by pressure of both the end and the handle of a file on the hands.

3. The lack of the ability to co-ordinate movement of hands, arms, body and legs, and lack of kinesthetic sense\(^1\) to regulate the whole movement.

I am not convinced that this problem was due to lack of understanding about movements and techniques in regulating forces because this problem still existed after my 15 minute demonstration and even the constant personal guidance given to some students. It is more likely dependent upon hereditary factors of individual students, which made students different from each other.

This problem was of course very common among beginners, but it was very painful and discouraging. Many beginners disliked this work very much the first time and turned it down very soon. Verbal feedback (such as personal comments) or pictorial guides seemed to be of little help at this very early stage for some students. A teacher should recognise that some students are handicapped in co-ordinating their movements and with lack of kinesthetic sense. The teacher's guidance and encouragement were constantly needed and completely essential.

c) Sawing and chiselling

The day after studying the theory of saws and sawing, and on chisels and chiselling, the CC and ACC students practiced these skills (see Appendix B7), for the first time. Conditions here were slightly different from those for filing discussed previously, students were provided with neither a pictorial sequence of operations nor solutions to problems, but simply a list of tasks to be performed.

The ACC students practiced this exercise in the morning and the CC students in the afternoon. This was due to shortage of tools and equipment. A workshop teacher helped me to supervise the ACC students and another one helped with the CC students. Student performances were judged as right or wrong according to a list of

\(^1\) Seymour, 1966, Industrial skills, p.11.
the observation sheet mentioned earlier. Prior to practice students were briefed about their work.

From our observations the following results were found:
1. A few minutes after commencing work many ACC students came to ask for a sequence of operations.
2. No mistakes were found in clamping work for sawing, in fixing a saw blade, or in hold a saw frame.
3. Two (11%) of the ACC students and none of the CC students made the mistake of sawing with too high a sawing angle.
4. Two (11%) of the ACC students and two (11%) of the CC students made a mistake in movement of the saw (jerking and/or twisting it).
5. More than 80% of both classes had difficulty in holding a chisel and a hammer, in striking with the hammer and in keeping an eye on the cutting edge of the chisel. They were interrupted and I gave them an additional demonstration. Constant help and guidance were also given to ensure their safety.

4.4.3.2 DISCUSSION

From results above four points for discussion were distinguished as follows:
1. There was a problem in the sequence of operations.
2. The operations of clamping work, fixing a sawblade, and holding the saw frame were successful.
3. Some mistakes were made in sawing.
4. Many mistakes were made in chiselling.

The problem of the sequence of operations, implied that students did not know which operation to start first and which to follow with. This could be explained as due to:
1. Lack of knowledge and experience in planning and working. To be able to plan even a small sequence of operations required both knowledge and experience in working and planning. The knowledge provided earlier had been merely for communication and general working and safety.
2. Lack of self-confidence as a consequence of lacking knowledge and experience in planning. The students did
not want to risk making any mistakes.

This problem was in fact expected, the exercise was designed on purpose to identify the important role of a sequence of operations and to remind students to think before working.

For successful operations in clamping work, fixing a sawblade and holding the saw frame, could be explained as due to:

1. The fact that the skills required in these operations were simple and similar to everyday skills, except that of holding a saw frame.

2. The possibility that the knowledge required to identify correct steps of actions could be accomplished by a combination of background knowledge and common sense, such as identifying the direction of saw teeth and the direction of sawing and their relationship.

3. The fact that students had learned information in clamping works for both sawing and chiselling and had already practiced clamping earlier on.

Some mistakes found in sawing were small in terms of absolute number and frequency. But there was a case to explain as follows:

1. Some students used the saw at a steep sawing angle. This was probably due to a lack of awareness of a rule of sawing. Alternatively, they might have felt that they could saw harder and more quickly at that steep angle.

2. Some students had difficulty in steadying their sawing. This was probably due either to the fact of the material being too thin to provide sufficient support for the saw, or to lack of ability in regulating hand forces in relation to changes of leverage distance of the saw. This point was really a matter of individual initial ability and sense (kinesthetic sense).

The high percentage of students making mistakes in chiselling, as mentioned above, could be explained as due to:

1. The reaction force to hammering which caused constant bouncing of the chisel. This reaction force was too great to maintain hand stability. Consequently, students were cautious for their own safety lest the hammer should miss its target and hit the hand.

2. The psychological effect resulting from awareness of possible accidents and danger in chiselling. This led to
a diminishing of striking force, changing of eye contact from aiming the cutting edge of the chisel to aiming the hammer at the end of the chisel, and maintaining the hand position at the middle of the hammer.

3. Lack of working experience sufficient to anticipate the effect of a bouncing chisel, maintain eye contact at the cutting edge of a chisel, control and stabilize the force of the hands, and to stabilize the speed and stroke of the hammer.

4.4.4. CONCLUSION

As results showed in filing, verbal information given in form of a sequence of operations or in case of sawing and chiselling, a workshop talk and demonstration seemed to have little effect on student skills. External feedback from the teacher in the form of direct guidance seemed to be more effective than a mere verbal comment, for some students.

These findings were contradictory to those found in layout work in which a pictorial sequence of operations was sufficient for students and no teacher's help was needed for external feedback. This could be explained by the complexity of skills involved and as a consequence of work in which the danger of an accident existed. Using this evidence I may conclude that:

1. Information in the form of a pictorial sequence of operations was sufficient for simple work where steps in the task demanded similar skills to everyday experiences. It was also sufficient as external feedback.

2. For difficult work which demanded a high level of co-ordinating skills and possibly with a degree of risk involved, it was essential to provide a constant external feedback in the form of at least direct oral information (comments) and wherever possible guidance.

3. With work that demanded skills of an intermediate level eg. like sawing, it was desirable to provide external feedback at least in form of information such as written comments or pictorial or object displays and direct oral comments if at all possible.
4.5 OTHER QUALITIES OF A PROGRAMMED TEXT

4.5.1 Rationale

Every programmed text of my design was constructed and implemented for the first time. It would be understandable if some parts of it were not as good as expected, despite careful planning, design and construction.

The effectiveness of a programmed text thus far was evaluated in terms of student achievement in the self-study method compared with the lecture method. It did not provide appropriate information to pinpoint ineffective areas or components of the programmed text. It is necessary however, to evaluate directly the effectiveness of the programmed text, so that improvement or modification of the design and construction of the text can be carried out later. The evaluation in this section, however, will be made on qualities of the programmed text.

4.5.2 Instrumentation

Each programmed text of my design (see column 1, Table 4.5) consisted of components necessary to provide a meaningful teaching-learning situation for students. Each component had its own unique function to facilitate student learning. Its effect could not be measured quantitatively but could however be measured in terms of a qualitative judgement of its merit.

Students who used the programmed text were considered as suitable representatives to bring about reliable reflection on the quality of the programmed text. Because they had used them throughout their experiments. There were, however, some limitations on students due to their lack of knowledge and understanding of the technical complexity of characteristics of programmed text components, such as appropriateness of observable performance objectives, or appropriateness of learning strategies. Therefore, the scope and parameter for each component (see column 2, Table 4.5) were limited to the level of student understanding and perception.
The evaluation sheet used in this case contained 28 items in two parts. In the first part students were asked to judge the quality of programmed text components first according to a list of parameters on a 5 point scale, i.e. very good, good, fair, poor and very poor; and second according to five options, two positive, one neutral, and two negative.

<table>
<thead>
<tr>
<th>Components</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
<td>1. Clarity</td>
</tr>
<tr>
<td>2. Objectives</td>
<td>2. Appropriateness</td>
</tr>
<tr>
<td>3. Learning hints</td>
<td>3. Interest</td>
</tr>
<tr>
<td>4. Informations</td>
<td>4. Relevance</td>
</tr>
<tr>
<td>5. Illustrations</td>
<td>5. Availability</td>
</tr>
<tr>
<td>7. Tests and solutions</td>
<td>7. Difficulty level</td>
</tr>
<tr>
<td>8. Exercises and solutions</td>
<td>8. Length, number</td>
</tr>
<tr>
<td>9. Time</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.5 Components and parameters constituting the evaluation sheet for the quality of a programmed text.
4.5.3 **ANALYSIS**

With each item having its own meaning it is possible to determine percentages of preference of students for each item. Decision for improvement will be based on the majority of students on each item. The following are decision criteria for the first part:

1. Retain if the majority was on positive preference.
2. Improve if the majority was on neutral and
3. Modify if the majority was on negative preference.

And the following are decision criteria for the second:

1. Retain if the majority found no hardship, and
2. Modify if the majority found hardship.

4.5.4 **RESULTS**

Half of the mixed CC and ACC students were asked to evaluate a number of programmed texts which they had just completed either at home or elsewhere. They were requested to return the completed evaluation sheet within two days. The following are results and interpretation of the evaluation on the programmed text, 'Vernier Caliper', judged by 18 (95%) CC and ACC students.
<table>
<thead>
<tr>
<th>Component/Parameter</th>
<th>Number (percentage) of student evaluations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very good</td>
</tr>
<tr>
<td>1. Relevance of introduction to contents of the topic.</td>
<td>2 (11.1)</td>
</tr>
<tr>
<td>2. Clarity of activities and contents of items of the learning objectives.</td>
<td>0 (0)</td>
</tr>
<tr>
<td>3. Clarity of learning guide to use of the programmed text.</td>
<td>2 (11.1)</td>
</tr>
<tr>
<td>4. Clarity of subject contents.</td>
<td>3 (16.7)</td>
</tr>
<tr>
<td>5. Appropriateness of sequence of subject contents.</td>
<td>1 (5.6)</td>
</tr>
<tr>
<td>6. Appropriateness of language used in subject contents.</td>
<td>1 (5.6)</td>
</tr>
<tr>
<td>7. Appropriateness of meaningfulness of subject contents.</td>
<td>2 (11.1)</td>
</tr>
<tr>
<td>8. Interest of subject contents.</td>
<td>1 (5.6)</td>
</tr>
<tr>
<td>9. Relevance of illustration to subject contents.</td>
<td>5 (27.8)</td>
</tr>
<tr>
<td>10. Clarity of illustrations.</td>
<td>4 (22.2)</td>
</tr>
<tr>
<td>11. Interest of illustrations.</td>
<td>1 (5.6)</td>
</tr>
<tr>
<td>12. Availability of learning aids.</td>
<td>5 (27.8)</td>
</tr>
<tr>
<td>13. Ease of use of learning aids.</td>
<td>3 (16.7)</td>
</tr>
<tr>
<td>14. The degree to which learning aids facilitate understanding of subject contents.</td>
<td>3 (16.7)</td>
</tr>
<tr>
<td>15. Clarity of direction in the post-test.</td>
<td>5 (27.8)</td>
</tr>
<tr>
<td>16. Relevance of questions in the post-test to subject contents.</td>
<td>5 (27.8)</td>
</tr>
<tr>
<td>17. Clarity of solutions of the post-test.</td>
<td>3 (16.7)</td>
</tr>
<tr>
<td>18. Clarity of directions of exercises.</td>
<td>1 (5.6)</td>
</tr>
<tr>
<td>19. Relevance of exercises to subject contents.</td>
<td>1 (5.6)</td>
</tr>
<tr>
<td>20. Appropriateness of language used in exercises.</td>
<td>1 (5.6)</td>
</tr>
<tr>
<td>21. Interest of exercise.</td>
<td>3 (16.7)</td>
</tr>
<tr>
<td>22. Clarity of solutions given to exercises.</td>
<td>2 (11.1)</td>
</tr>
</tbody>
</table>
### Component/Parameter

<table>
<thead>
<tr>
<th></th>
<th>Number (percentage) of student evaluations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Difficult</td>
</tr>
<tr>
<td>1. How difficult are the subject contents?</td>
<td>2 (11.1)</td>
</tr>
<tr>
<td>2. How difficult is the post-test?</td>
<td>1 (5.6)</td>
</tr>
<tr>
<td>3. How difficult are the exercises?</td>
<td>1 (5.6)</td>
</tr>
<tr>
<td>4. Is the length of the topic suitable?</td>
<td>0 (0)</td>
</tr>
<tr>
<td>5. Is the number of questions in the post-test suitable?</td>
<td>0 (0)</td>
</tr>
<tr>
<td>6. Are the number of exercises suitable?</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>
Using the established decision criteria mentioned above, it was found that:

12 (54.4%) of the items for part I can be retained.
10 (45.5%) of the items for part I need some improvement.
None of part II needs further modification, and so all of it can be retained.

Table 4.6 shows items which need further alternation for "Vernier Caliper".

<table>
<thead>
<tr>
<th>Part I</th>
<th>to be retained</th>
<th>to be improved</th>
<th>to be modified</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 7 8</td>
<td>3 4 5 6</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>9 10 11 13</td>
<td>12 15 16 19</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>14 17 18 22</td>
<td>20 21</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Part II</td>
<td></td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>1 2 3 4</td>
<td>none</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>5 6</td>
<td>none</td>
<td>none</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.6 Items on the evaluation sheet and the necessary treatment for the programmed text 'Vernier Caliper'.

4.5.5. DISCUSSION

Having referred to items on the evaluation sheet where some modifications are needed and to the programmed text itself, a number of points can be made as follows:

1. The clarity of language in some parts of the programmed text was not as good as expected. This could be because some information might have been too condensed, or missing altogether. It is unlikely that it was too long. Also, some parts might have contained ambiguous terms, a lack of examples, or sentences were not well constructed.

2. Sequence of subject matter was inappropriate. This was probably due to information in an incorrect order or to steps which were too large.

3. Learning aids were not sufficient. This was undoubtedly due to a restricted budget.

4. Exercises and post-test were not relevant. This might be
because the questions demanded too high a level of intellectual skill or because there was no information available. In this respect additional information or clues to questions should be added.
5.1 OVERVIEW

This chapter deals with development of the student's workshop knowledge. There are three different aspects concerned: 1) workshop knowledge in the study unit stage, 2) workshop knowledge in benchwork theory and 3) workshop knowledge in technical drawing. Both workshop knowledge in the study unit stage and workshop knowledge on benchwork theory are concerned with the same topics or contents. The difference between them lies on the matter of test construction. The former is a collection of post-tests of 11 study programmed texts provided to students in the study unit stage (the first stage of the system), whereas the latter is an achievement test constructed separately to cover the contents of all those study programmed texts. For workshop knowledge in technical drawing, another achievement test is constructed separately to cover all the contents specified in the training specification in respect to areas concerned with technical drawing. There was no study programmed text provided for students in this part in their training.

In relation to courses allocated to students in the second semester when this training system was being implemented, a course on metal trade principles (1) also dealt with the same contents or topics as those in benchwork theory and study programmed texts. This is a course given in a normal classroom, emphasizing more the theoretical basis. The contents of part one (the first half of the semester) of this course contained the same topics as those in benchwork theory and study programmed texts. However the contents on part two were beyond the scope of this investigation.

The investigation in this chapter will be in the following sequence:

1. The immediate achievement of students on 5 or 6 topics of study unit programmed texts which were experimentally tested under close supervision.

2. The short term retention of students in 6 topics or study unit programmed texts which were experimentally tested under close supervision.
3. The medium term retention of students on all 11 topics of study unit programmed texts.

4. The development of the students' knowledge of benchwork theory over 5 stages of this course.

5. The influence of factors concerned on the development of the students' knowledge of benchwork theory over all stages of this course.

6. The development of the students' knowledge of technical drawing over 5 stages of this course.

5.2 A GENERAL MODEL OF THE LEARNING SYSTEM FOR WORKSHOP KNOWLEDGE

The development of students' workshop knowledge in this course took place mainly in the study unit stage of my training system, in which the students studied a number of programmed texts and attended lectures. In later stages students concentrated on benchwork production exercises. Some additional workshop knowledge was gained from subsequent training stages as a result of the insights and experience from the benchwork production exercises. But some previously acquired knowledge might have been either forgotten or strengthened in the course of time and later activities. This phenomena will appear later in this chapter.

Students also attended a course on metal trade principles (1) and acquired more or strengthened existing knowledge given in the study unit stage. In these circumstances, there was an interaction and integration in the cognitive structure of the students between knowledge and experience gained from the training and knowledge acquired in the classroom. To some extent this leads to increases in workshop knowledge. Notice that the lessons given in the classroom were in fact delivered once a week and not repeated by the lecturer. Thus, gains as well as losses of some of the workshop knowledge might possibly occur depending upon the use and recall on workshop exercises at various stages in the training.
The timetable of both workshop training and classroom teaching given in Appendix A12, shows the dates of events in workshop training, topics taught in the classroom and tests. Notice that the topics taught in the classroom after the midterm test (or equivalent) up to the end of the exercise unit stage, are beyond those given in the study unit stage; and they are not covered in benchwork theory test which will be discussed later.

A general model of the learning system of workshop knowledge discussed above is depicted in diagram 5.1.

Diagram 5.1 A model of the learning system of workshop knowledge, workshop training and classroom teaching.
As I intended to overcome some of the limitations of the lecture method used in workshop teaching, a number of other learning methods and conditions were introduced. Results from rigorous research findings on this matter will provide evidence to support as well as highlight some of the possibilities of other teaching-learning methods. This should be beneficial to the teachers, students and/or administrators concerned. The consequences would be aimed towards encouraging teachers to realise the role of other learning methods which might be used as alternatives for reducing their teaching loads, and at the same time for improving teaching-learning effectiveness and efficiency.

The following are the aims of the study on the development of students' workshop knowledge:

1. To determine the amount of learning resulting from different teaching-learning methods on a number of study unit topics.

2. To determine the retained knowledge of students on study unit topics at the end of the study unit stage (short-term retention) and at the end of the exercise unit stage (i.e., medium-term retention).

3. To determine the performance changes of students in both benchwork theory and technical drawing from the pre-system stage to the end of the course.

4. To determine the relative influence of the components in learning-training situation within the models of learning system, on students' knowledge, i.e., on study unit topics, benchwork theory, and technical drawings.

5.4 MEASURING INSTRUMENTS AND TESTS

Workshop knowledge in this training course is divided into knowledge of benchwork theory and technical drawing. For benchwork theory there were four different sets of tests used, including two tests administered for the classroom taught course in metal trade principles (1). Details of all tests are given below.
(a) **Criterion test** This test is in fact the collection of all the post-tests from every study unit topic given in the study unit stage. The sample of this test is given in Appendix C5. This test was administered at the end of the study unit stage and the end of the exercise unit stage. The reliability of this test using data from the test administered at the end of the exercise unit stage was 0.8 and standard error of measurement 3.9, as computed with the KR 21 formula.

(b) **Achievement test on benchwork theory** This test was constructed on the basis of contents chosen from the list of stated training specifications of the training course. Contents covered in this test were equivalent to topics given in classroom teaching Part 1. There were 77 objective type items on this test. A sample is given in Appendix C3. This test was administered together with the test on technical drawing, described below, on five occasions: the pre-system stage, study unit stage, consolidating unit stage, exercise unit stage and the end of the course. The reliability of this test was 0.7 and standard error of measurement 4.5 (using data from a sample of the previous semester first year skilled worker students), as computed with the KR 21 formula.

(c) **Metal Trade Principles, Part 1 test** This test was constructed by the teacher in charge of classroom teaching, covering all topics in the first part of this subject, see Appendix A12. It was administered at the mid-term of the semester. The test consisted of 90 objective type items. Its reliability coefficient was 0.7 and standard error of measurement 4.2, as computed with the R20' formula.

(d) **Metal Trade Principles, Part 2 test** This test was constructed by the teacher in charge of the course, covering all topics taught in the course, i.e., including topics in Part 1. It was used for the final examination of the classroom teaching. The test consisted of 100 objective type items plus 2 essay items. The total maximum possible score of this test was 120 marks. Its reliability coefficient was 0.8 and standard error of measurement 5.3, as estimated with the R20' formula.
Technical drawing test. This test consisted of 14 items, a mixture of objective and essay type items, see Appendix C4. The contents of the test were selected from the training specification, see Appendix A6. For the following analysis data for part 2 of this test will be used. The reliability coefficient of this test on part 2 was 0.4, and standard error of measurement 3.0, as computed with the Alpha formula, based on data from a sample of the previous semester first year skilled worker students.

5.5 ANALYSIS AND RESULTS ON THE IMMEDIATE ACHIEVEMENT, THE SHORT-TERM RETENTION, AND THE MEDIUM-TERM RETENTION OF STUDENTS, ON STUDY PROGRAMMED TEXTS

The following analysis and results will concentrate on the development of students' knowledge and factors affecting students' learning on study unit topics.

5.5.1 MODELS AND ANALYSIS OF STUDENTS' KNOWLEDGE ON STUDY PROGRAMMED TEXTS AND FACTORS AFFECTING THEIR LEARNING

I would like to highlight three periods of change in students' knowledge on study unit topics, i.e., study period, short-term retention period, and medium-term retention period.

a) The learning period (immediate achievement). The incoming students entered into the first stage (study unit stage) of the training with some pre-knowledge in relation to workshop knowledge concerned, but it was regarded as insufficient for them to carry out the workshop exercises to be given in subsequent stages. Thus, they would need to study a number of topics which were planned and constructed for them. It was hypothesized that the intervention of teaching or learning of each individual study unit topic given in the study unit stage will cause a positive change in the level of students' knowledge, i.e., students will gain more knowledge.

Four study unit topics, as discussed previously in chapter 4, will be analysed at this stage on the development of students' knowledge and factors affecting their development. But one topic on the techniques in filing flat work for which the pre-test and the post-test were not equivalent in terms of number of test items will not be
included. In addition, another two topics taught by myself, using the lecture method to all CC and ACC students, will be analysed in the same manner. Other topics for the rest will not be analysed at this stage, as there was no control over students' learning in their own time, or no pre-test and post-test accompanied by the study unit programmed texts.

Changes on students' learning of these five study unit topics can be determined and tested for statistical significance, by using the t-test for the matched pair data formula. And the Pearson's product moment correlation will be used to estimate the degree of learning due to pre-knowledge of students.

b) The second period, or the short-term retention The students were tested with the same post-tests of all study unit topics at the same time. But, only six study unit topics will be analysed for changes in the level of students' knowledge. Five topics are the same as those analysed in the first period, as mentioned above, and the new one is in fact the topic on the techniques in filing flat work. This time, however, the analysis will be on the basis of the students' classes rather than the mixed groups, since this experimental condition did not hold here.

The short-term retention is the period where the students have completed their study on all study unit topics. That is the period from the end of each individual study unit topic until the end of the study unit stage. During the meantime some students might have reviewed their study unit topics while others not. There was no control whatsoever on individual students after the completion of each study unit topic. In these circumstances, students may show either a gain or a loss in their knowledge of some topics. Losses in knowledge are due to forgetting as found by Hermann Ebbinghaus (1885), whereas gains are due to relearning. Other factors might account for these changes such as boredom, illness, halo effect, etc. The amount of these changes and their directions will be shown in the analysis.

During the study unit stage, there was only one topic given on measuring and gauging in the classroom teaching. This topic was regarded as a general orientation to the process of measuring and gauging for industrial work and was considered as having no effect on students' learning of study unit topics.
The procedures used for determining the level of students' knowledge at this stage and in the test for statistical significance are the same as those mentioned in the first period. And the Pearson product moment correlation formula is used to determine the influence of post-test knowledge on the retained knowledge at the end of the study unit stage.

c) The medium-term retention  Both CC and ACC students were tested with the same post-test of all study unit topics as in the second period, at the same time by the end of the exercise unit stage.

After the study unit stage all students followed the same sequence of workshop exercises (U-shape work) in the practice unit stage. But, in the exercise unit stage which followed the consolidating unit stage, students could choose their own sequence of workshop production exercises (a small vice) and planned their own operation sheets where in the practice unit stage this was given. This planning activity and production of workpieces would require from students some knowledge previously learned in the preceding stages. At the same time they may have acquired some knowledge from the exercises through their success and failure.

Not all study unit topics would be recalled in workshop production practice. This was already shown in the analysis of the workshop exercise project, Appendix A2. Three study unit topics which are not involved in workshop production exercises part no. 5, 6, and 7, of the exercise unit stage, are universal bevel protractors, dial indicators, and the use of the chisel. It is doubtful whether this factor may influence the level of retained knowledge of students on the corresponding study unit topics. By grouping topics into used and unused groups and correlating them with the later performances would provide some information.

The amount of knowledge which might be gained from experience in benchwork production exercises could not be determined directly with the present design of the training system and the limited number of intact students. It is conceptualized, however, that this knowledge will be stored in the cognitive structure of individual students and to some extent integrated with the knowledge from study unit topics, and the classroom teaching on the metal trade principles (1). Therefore students' knowledge of benchwork theory, technical drawing, and classroom teaching will be used for correlational studies in order to determine their relative influences on the medium term-retention of
study unit topics.

Another factor which may have a direct influence on the current retained knowledge of students on study unit topics at the end of the exercise unit stage, is the previously retained knowledge of each particular study unit topic itself. The product moment correlation will be used to determine this influence.

The model of factors affecting the level of knowledge currently retained at the end of the exercise unit stage is depicted in diagram 5.2.

Diagram 5.2 A model of factors affecting on the retained knowledge on study unit topics at the end of the exercise unit stage.

The amount of change in the level of students' knowledge and the direction in the study unit topics will be determined by using the same t-test formula as mentioned previously.

5.5.2 RESULTS ON STUDENTS' KNOWLEDGE OF STUDY PROGRAMMED TEXTS

The results on the development of students' knowledge on study unit topics and factors affecting student learning will be presented in three subsequent periods: learning period (immediate achievement), short-term retention period, and medium-term retention period.
In this period I hypothesized that the intervention of teaching-learning events will cause a statistically significant increase on the level of the students' knowledge of each study unit topic. Results on the pre-test, post-test, and average gain scores for each group/class of students on five study unit topics are given in Table 5.1.

From the table it was found that students on average in each group/class obtained more knowledge by the end of their study (i.e., on the post-test). For all topics the average gain scores have statistical significance at 99% confidence level. This gives enough evidence to support my hypothesis and it confirms that the intervention of teaching-learning events did cause a statistically significant increase on the level of students' knowledge on study unit topics. The findings of the experiments yielded consistent results for both groups/classes on all topics. This gives strong support for the conclusion that the following teaching-learning methods, and conditions were successful, as far as students' gained knowledge were concerned:

1. My programmed text and my lecture on dial indicators.
2. Commercial texts with solutions given to the exercises or without the solutions given to the exercises on both the use of the saw, use of the chisel.
3. My lecture on universal bevel protractors, and measurement of squareness.

At this stage, however, it was not known whether the success of students' performances on the post-tests was dependent on their pre-knowledge. In the next stage I will determine the relationship of student performances between the post-test and the pre-test on each study unit topic.
<table>
<thead>
<tr>
<th>Topic</th>
<th>Poss. marks</th>
<th>Method</th>
<th>Group/Class</th>
<th>N</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Gain score</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>S.D</td>
<td>X</td>
<td>S.D</td>
</tr>
<tr>
<td>1. Dial indicators</td>
<td>6</td>
<td>Lecture</td>
<td>G2 + G4</td>
<td>18</td>
<td>3.1</td>
<td>1.6</td>
<td>5.4</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self-study</td>
<td>G1 + G3</td>
<td>18</td>
<td>2.0</td>
<td>1.3</td>
<td>5.2</td>
<td>1.2</td>
</tr>
<tr>
<td>2. Use of the saw</td>
<td>12</td>
<td>Solu. given</td>
<td>G1 + G4</td>
<td>19</td>
<td>4.5</td>
<td>1.2</td>
<td>6.9</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solu. not given</td>
<td>G2 + G3</td>
<td>19</td>
<td>4.3</td>
<td>1.7</td>
<td>7.4</td>
<td>2.0</td>
</tr>
<tr>
<td>3. Use of the chisel</td>
<td>17</td>
<td>Solu. given</td>
<td>G2 + G3</td>
<td>19</td>
<td>3.3</td>
<td>2.0</td>
<td>11.9</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solu. not given</td>
<td>G1 + G4</td>
<td>19</td>
<td>3.5</td>
<td>1.6</td>
<td>11.4</td>
<td>2.4</td>
</tr>
<tr>
<td>4. Univ. bevel protractor</td>
<td>10</td>
<td>Lecture</td>
<td>CC</td>
<td>17</td>
<td>3.8</td>
<td>2.0</td>
<td>6.5</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ACC</td>
<td></td>
<td>18</td>
<td>2.7</td>
<td>1.7</td>
<td>5.7</td>
<td>1.5</td>
</tr>
<tr>
<td>5. Measurement of surface level</td>
<td>16</td>
<td>Lecture</td>
<td>CC</td>
<td>17</td>
<td>4.5</td>
<td>2.0</td>
<td>13.5</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ACC</td>
<td></td>
<td>18</td>
<td>5.0</td>
<td>2.3</td>
<td>12.2</td>
<td>3.1</td>
</tr>
</tbody>
</table>

N = Number of students

** p < 0.01

Table 5.1 Gain scores on students' learning from various learning methods and conditions on five study unit topics.
By using the Spearman product moment correlation, results on the relationship between the pre-test and the post-test for each group/class on five study unit topics were obtained as shown in Table 5.2.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Method</th>
<th>Group/Class</th>
<th>Degree of freedom</th>
<th>Correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dial indicators</td>
<td>Lecture</td>
<td>G2 + G4</td>
<td>16</td>
<td>0.5*</td>
</tr>
<tr>
<td></td>
<td>Self-study</td>
<td>G1 + G3</td>
<td>16</td>
<td>0.1</td>
</tr>
<tr>
<td>2. Use of the saw</td>
<td>Solu. given</td>
<td>G1 + G4</td>
<td>17</td>
<td>-0.0</td>
</tr>
<tr>
<td></td>
<td>Solu. not given</td>
<td>G2 + G3</td>
<td>17</td>
<td>0.4</td>
</tr>
<tr>
<td>3. Use of the chisel</td>
<td>Solu. given</td>
<td>G2 + G3</td>
<td>17</td>
<td>0.6**</td>
</tr>
<tr>
<td></td>
<td>Solu. not given</td>
<td>G1 + G4</td>
<td>17</td>
<td>0.2</td>
</tr>
<tr>
<td>4. Univ. bevel</td>
<td>Lecture</td>
<td>CC</td>
<td>15</td>
<td>0.4</td>
</tr>
<tr>
<td>protractor</td>
<td>ACC</td>
<td>16</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>5. Meas. of surf. level</td>
<td>Lecture</td>
<td>CC</td>
<td>15</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>16</td>
<td>0.5*</td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.05  ** p < 0.01

Table 5.2 Correlation coefficient on relationship between the pre-test and post-test on five study unit topics.

From the results on the table above, it was found that correlation between pre-test and post-test for these topics ranged from 0 to 0.6, i.e., from no relationship at all to moderate relationship. For the combination of CC and ACC students in group 2 and group 3 on the use of the saw, and use of the chisel, the correlation coefficient were moderate. But only on the use of the chisel was a statistically significant relationship found at 99% confidence level.

On the other hand between group 1 and group 4 on the same topics there was either no relationship or very low relationship. These contradictory results indicated that the performance of students for some groups were dependent upon the level of students' pre-knowledge while for others it was not.

The similar mixed results on the relationship between the pre-test and the post-test were also found on all other topics. Edney (1972) mentions that a programme appearing early in the instructional
system showing an excessively high correlation due to initial knowledge may be troublesome, if the pre-knowledge is uncontrolled and has not been provided earlier in the training.

b) The short-term retention

After the completion of each study unit topic, it was possible that students did review some topics in one way or another, or did not review any topic at all until the end of the study unit stage. Under these circumstances, it was possible that students might gain or lose some of the knowledge acquired at the learning period.

Results on the short-term retention test given in Table 5.3 show scores on the post-test, the retention test (1), and the difference scores from post-test to retention test, on six study unit topics for both CC and ACC students.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Class</th>
<th>N</th>
<th>Post-test</th>
<th>Retention test (1)</th>
<th>Difference score</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>( \bar{X} )</td>
<td>S.D</td>
<td>( \bar{X} )</td>
<td>S.D</td>
</tr>
<tr>
<td>1. Dial indicators</td>
<td>CC</td>
<td>18</td>
<td>5.5</td>
<td>0.8</td>
<td>4.8</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>18</td>
<td>5.1</td>
<td>1.1</td>
<td>4.7</td>
<td>1.2</td>
</tr>
<tr>
<td>2. Use of the saw</td>
<td>CC</td>
<td>18</td>
<td>7.2</td>
<td>1.4</td>
<td>9.6</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>20</td>
<td>6.7</td>
<td>1.9</td>
<td>8.3</td>
<td>2.3</td>
</tr>
<tr>
<td>3. Use of the chisel</td>
<td>CC</td>
<td>18</td>
<td>11.9</td>
<td>2.5</td>
<td>12.7</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>20</td>
<td>11.3</td>
<td>2.8</td>
<td>12.9</td>
<td>2.5</td>
</tr>
<tr>
<td>4. Univ. bevel protractors</td>
<td>CC</td>
<td>17</td>
<td>6.5</td>
<td>0.9</td>
<td>6.6</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>18</td>
<td>5.7</td>
<td>1.5</td>
<td>5.4</td>
<td>1.3</td>
</tr>
<tr>
<td>5. Meas. of surf. level</td>
<td>CC</td>
<td>17</td>
<td>13.5</td>
<td>1.9</td>
<td>12.8</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>18</td>
<td>12.2</td>
<td>3.1</td>
<td>13.4</td>
<td>2.6</td>
</tr>
<tr>
<td>6. Tech. in filing</td>
<td>CC</td>
<td>18</td>
<td>7.4</td>
<td>1.1</td>
<td>7.9</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>17</td>
<td>7.5</td>
<td>1.2</td>
<td>7.4</td>
<td>0.8</td>
</tr>
</tbody>
</table>

\( N = \text{Number of students} \quad * p < 0.05 \quad ** p < 0.01 \)

Table 5.3 Test results on post-test and retention test (1) at the end of the study unit stage showing gains and losses on six study unit topics for CC and ACC students.
From the table, it was found that two topics on use of the saw, and use of the chisel had shown consistent gains from post-test to retention test (1) for both CC and ACC students. All gain scores on these two topics were statistically significant, at 95% except for the CC class on use of the chisel.

Losses from post-test to retention test (1) were found on dial indicators for both classes, and it was statistically significant for CC class, at 95% confidence level.

Mixed results of both gains and losses were found for both classes on universal bevel protractors, measurement of surface level, and techniques in filing flat work. Among these results a gain of difference scores for ACC class on measurement of surface level had statistical significance, at 95% confidence level.

Consistent results and the statistical significance of gains on use of the saw, and use of the chisel implied that relearning on these topics took place in some form after the learning period. It could be due to students reviewing their studies, or being refreshed after the post-test in which they had discussed their test performances.

The increase on the level of knowledge on some of these topics might be due to under-learning during the learning period. The indicator for this argument was from the average achievement of students on the post-test. For example, performances of CC and ACC student on use of the chisel were moderate, i.e., 70%, 67% respectively. In this circumstance, it is quite likely that students would gain more knowledge if they had reviewed their studies.

Losses of knowledge for both CC and ACC students on dial indicators could be explained as the result of a number of aspects such as the lack of retrieving capability, lack of awareness, and retroactive interference of subsequent learning.

The first aspect of retrieving capability involves both the ability to recall and recognize the meaning of previously learned information. This aspect is described in Tulving (1973). Students in this case might not be able to organize their knowledge and anchor it to any specific concrete events or ideas in their cognitive structure; or it might be due to the context in the programmed text or lecture was lacking in establishing specific cues for recall or recognition.

Another aspect of loss of learned knowledge might be due simply to students lacking awareness or losing self-motivation. They
might intend to forget the topic as they thought it would never be used in practice. This might be the case because students knew which tools or instruments they were not allowed to borrow or use in their training. Bjork (1970) found that items which were signaled to the subjects not to be remembered are not retained as well as those to be remembered. Spector, Laughery, and Finkelman (1973) showed that the learners do not rehearse the words that are to be forgotten; they read them and work on remembering the words to be remembered. At the end of the list they will review in their minds the words to be remembered, but not the words to be forgotten.

Retroactive interference probably applies in this case as well. This type of interference is caused by a depressing effect of subsequent learning on retention of the topic previously learned (see Travers, 1977). It was not known whether the present network diagram would involve this negative effect or not. Further experiments into this factor need research beyond the scope of this study.

The mixed results of gains and losses on universal bevel protractors, measurement of surface level, and techniques in filing flat work, might be accounted for by a number of factors such as the regression effect, and others as already discussed above.

Regression toward the mean would be exhibited in these mixed results by which students who earned a high score on the post-test now earned a lower score on the retention test, whereas students with a low post-test score now earn a higher score on the retention test. Borg and Gall (1971) mention that regression effect occurs because of errors of measurement and tests used are correlated to each other.

By carefully studying the changes of mean scores on both tests for CC and ACC classes on the three topics, with mixed results, only measurement on surface level would be effected by the regression effect. There, a high mean score on the post-test of the CC class went with a lower one on the retention test, whereas a low mean score on the post-test of the ACC class went with a higher one on the retention test. This is not the case for the other two topics. They are both characterized in the same manner, i.e., CC students performed better on the retention test than the post-test, but ACC students performed less well on both tests. Notice that these changes of mean scores were not large enough to be statistically significant. Therefore, it might be due to chance alone or slight errors on the measurements used.
c) The medium-term retention

The same post-test of all study unit topics were administered to both classes at the same time. The time elapsed between the end of the study unit stage and the end of the exercise unit stage was 56 days. Between these two tests students of both classes had experienced a series of workshop production exercises, and in addition they attended a number of topics in the normal classroom teaching as a part of their regular courses.

Results on 11 study unit topics given in Table 5.4 show mean scores on the retention test (1), retention test (2) and the difference scores. Three categories of results were found: a) all classes gained more knowledge, b) all classes lost some knowledge, and c) two classes either gained or lost some knowledge.

Five topics where gains in knowledge were found are:
- measurement of surface level.
- Vernier calipers.
- Layout work.
- Clamping work.
- Use of the file.

Three topics where losses in knowledge were found are:
- Dial indicators
- Use of the chisel
- Techniques in filing flat work.

The following three topics exhibited both gains and losses:
- Use of the saw
- Universal bevel protractor
- Measurement of squareness.

A remarkable contrast was found when these topics were grouped in relation to their use or not in benchwork production exercises, during the first half of the semester (see Table 5.5).
<table>
<thead>
<tr>
<th>Topic</th>
<th>Class</th>
<th>N</th>
<th>Retention test (1)</th>
<th>Retention test (2)</th>
<th>Difference score</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>S.D</td>
<td>X</td>
<td>S.D</td>
</tr>
<tr>
<td>1. Dial indicators</td>
<td>CC</td>
<td>18</td>
<td>4.8</td>
<td>1.1</td>
<td>4.4</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>4.7</td>
<td>1.2</td>
<td>4.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td></td>
<td>4.8</td>
<td>1.1</td>
<td>4.5</td>
<td>1.2</td>
</tr>
<tr>
<td>2. Use of the saw</td>
<td>CC</td>
<td>18</td>
<td>9.6</td>
<td>2.0</td>
<td>8.7</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>8.2</td>
<td>2.4</td>
<td>9.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td></td>
<td>8.9</td>
<td>2.3</td>
<td>8.9</td>
<td>1.4</td>
</tr>
<tr>
<td>3. Use of the chisel</td>
<td>CC</td>
<td>18</td>
<td>12.7</td>
<td>2.6</td>
<td>11.8</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>12.8</td>
<td>2.6</td>
<td>11.1</td>
<td>2.3</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td></td>
<td>12.8</td>
<td>2.5</td>
<td>11.5</td>
<td>2.2</td>
</tr>
<tr>
<td>4. Universal bevel protractor</td>
<td>CC</td>
<td>18</td>
<td>6.5</td>
<td>1.3</td>
<td>5.6</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>5.2</td>
<td>1.6</td>
<td>5.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td></td>
<td>5.8</td>
<td>1.6</td>
<td>5.5</td>
<td>1.4</td>
</tr>
<tr>
<td>5. Measurement of surface level</td>
<td>CC</td>
<td>18</td>
<td>12.6</td>
<td>2.3</td>
<td>13.1</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>13.1</td>
<td>2.9</td>
<td>13.9</td>
<td>1.6</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td></td>
<td>12.8</td>
<td>2.6</td>
<td>13.5</td>
<td>1.6</td>
</tr>
<tr>
<td>6. Vernier calipers</td>
<td>CC</td>
<td>18</td>
<td>5.5</td>
<td>1.2</td>
<td>5.6</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>5.1</td>
<td>1.3</td>
<td>5.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td></td>
<td>5.3</td>
<td>1.3</td>
<td>5.4</td>
<td>1.0</td>
</tr>
<tr>
<td>7. Measurement of squareness</td>
<td>CC</td>
<td>18</td>
<td>8.4</td>
<td>1.9</td>
<td>7.9</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>7.4</td>
<td>1.7</td>
<td>8.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td></td>
<td>7.9</td>
<td>1.8</td>
<td>8.0</td>
<td>1.4</td>
</tr>
<tr>
<td>8. Layout work</td>
<td>CC</td>
<td>18</td>
<td>7.6</td>
<td>2.0</td>
<td>7.7</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>7.4</td>
<td>2.4</td>
<td>8.6</td>
<td>2.3</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td></td>
<td>7.5</td>
<td>2.2</td>
<td>8.2</td>
<td>2.1</td>
</tr>
<tr>
<td>9. Clamping work</td>
<td>CC</td>
<td>18</td>
<td>3.7</td>
<td>0.9</td>
<td>4.0</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>3.4</td>
<td>1.3</td>
<td>3.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td></td>
<td>3.5</td>
<td>1.1</td>
<td>3.9</td>
<td>0.8</td>
</tr>
<tr>
<td>10. Use of the file</td>
<td>CC</td>
<td>18</td>
<td>10.6</td>
<td>1.7</td>
<td>10.9</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>10.7</td>
<td>1.5</td>
<td>10.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td></td>
<td>10.6</td>
<td>1.6</td>
<td>10.9</td>
<td>1.4</td>
</tr>
<tr>
<td>11. Techniques in filing flat work</td>
<td>CC</td>
<td>18</td>
<td>7.9</td>
<td>1.2</td>
<td>6.8</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>7.3</td>
<td>0.1</td>
<td>6.6</td>
<td>1.1</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td></td>
<td>7.6</td>
<td>1.1</td>
<td>6.7</td>
<td>1.1</td>
</tr>
</tbody>
</table>

** p < 0.01

Table 5.4 Test results on retention test (1) and retention test (2) at the end of the exercise unit stage showing gains and losses on 11 study unit topics.
Two out of three study unit topics whose knowledge is not used in benchwork production exhibited losses for both CC and ACC classes.

One out of eight study unit topics whose knowledge is used in benchwork production exhibited losses for both CC and ACC classes.

<table>
<thead>
<tr>
<th>Grouping</th>
<th>Result</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used knowledge</td>
<td>Gain</td>
<td>Measurement of surface level Vernier calipers Layout work Clamping work Use of the file</td>
</tr>
<tr>
<td></td>
<td>Loss</td>
<td>Techniques in filing flat work</td>
</tr>
<tr>
<td></td>
<td>Mixture</td>
<td>Use of the saw Measurement of squareness</td>
</tr>
<tr>
<td>Unused knowledge</td>
<td>Loss</td>
<td>Dial indicators Use of the chisel</td>
</tr>
<tr>
<td></td>
<td>Mixture</td>
<td>Universal bevel protractors</td>
</tr>
</tbody>
</table>

Table 5.5 Results on 11 study unit topics as grouping into used and unused knowledge in relation to benchwork production exercises within the first half of the semester.

The outcomes contrast quite clearly with the trend of the merit between study unit topics of use in benchwork production exercises. It implies that students were likely to retain knowledge better on topics used on benchwork production exercises.

Among these results, however, the topic on techniques in filing flat work needs further investigation into the student response plot, in order to identify those items in which students mostly failed to perform adequately.
The difficulty index\(^1\) of test items had been computed for all items of techniques in filing flat work, as shown in Appendix E2. Notice that one student was absent. It was found that items 2, 4a, and 4b, were too difficult for students (D-indices equal 0.08, 0.57 and 0.66 respectively).

Having considered the sample of these test items (see Appendix B1), it was found that

In item 2 there could be an ambiguity in the phrase 'in front of the filed workpiece'. Students might have thought it was in front of them or in front of the workpiece.

Item 4a and 4b might simply have been forgotten. Students might have thought that remembering the angle at which the feet should be positioned would not be required.

Based upon this interpretation, and if these three items were omitted it can be stated that in fact students could still retain most of their knowledge of this topic as well as the other topics used on workshop production exercises.

d) Factors affecting student learning on study unit topics

Retention of students on study unit topics at the end of the exercise unit stage was thought of as partly dependent upon their retention on the end of the study unit stage, classroom teaching, and experiences gained during benchwork production exercises. As the retention test (2) was the same as the retention test (1), therefore, the relationship of students' performances between the retention test (2) and the retention test (1) was regarded as the reflection

\[ D = \frac{\sum Rc}{N} \text{, where } Rc = \text{Numbers of correct responses on the item, } N = \text{Number of students.} \]
of students' abilities on recognition and recall of previously acquired knowledge.

Retention test (2) also related implicitly to benchwork theory test and the classroom teaching midterm test in terms of knowledge contents, as they shared the same topics. Retention test (2) might also require some of the abilities involved in technical drawing, as they are both concerned with drawings, dimensions and specifications.

Another aspect among these tests which is worthy of mention at this stage is the composition of test items. Retention test (2) was composed of the post-tests of 11 study unit topics, whereas, the benchwork theory test, classroom teaching midterm test, and technical drawing test consisted of contents sampled from a whole range of topics. The latter measures a gross achievement of a particular subject, but the former does on the individual topic.

The relationship between the retention test (2) and these tests including the retention tests (1) was determined in terms of correlation coefficients. The results were calculated from the data of 37 CC and ACC students, as shown in table 5.6. Interpretation of the results will be on separate pairs of correlation, and in terms of influences on students' performances on the retention test (2).
<table>
<thead>
<tr>
<th>Grouping</th>
<th>Topic</th>
<th>DF</th>
<th>R1R2</th>
<th>R2CT</th>
<th>R2BT</th>
<th>R2TD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge gained</td>
<td>1. Measurement of surface level</td>
<td>35</td>
<td>0.54**</td>
<td>0.52**</td>
<td>0.60**</td>
<td>0.46**</td>
</tr>
<tr>
<td></td>
<td>2. Vernier calipers</td>
<td>35</td>
<td>0.31</td>
<td>0.51**</td>
<td>0.37*</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>3. Layout work</td>
<td>35</td>
<td>0.39*</td>
<td>0.42**</td>
<td>0.60**</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>4. Clamping work</td>
<td>35</td>
<td>0.30</td>
<td>0.35*</td>
<td>0.36*</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>5. Use of the file</td>
<td>35</td>
<td>0.36*</td>
<td>0.29</td>
<td>0.20</td>
<td>0.24</td>
</tr>
<tr>
<td>Knowledge lost</td>
<td>6. Dial indicators</td>
<td>35</td>
<td>0.23</td>
<td>0.32</td>
<td>0.54**</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>7. Use of the chisel</td>
<td>35</td>
<td>0.34*</td>
<td>0.29</td>
<td>0.50**</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>8. Techniques in filing flat work</td>
<td>35</td>
<td>0.29</td>
<td>0.10</td>
<td>0.20</td>
<td>0.42**</td>
</tr>
<tr>
<td>Knowledge gained / lost</td>
<td>9. Use of the saw</td>
<td>35</td>
<td>0.27</td>
<td>1.00**</td>
<td>0.66**</td>
<td>0.57**</td>
</tr>
<tr>
<td></td>
<td>10. Universal bevel protractors</td>
<td>35</td>
<td>0.63**</td>
<td>0.25</td>
<td>0.32</td>
<td>0.35*</td>
</tr>
<tr>
<td></td>
<td>11. Measurement of squareness</td>
<td>35</td>
<td>0.15</td>
<td>0.36*</td>
<td>0.54**</td>
<td>0.47**</td>
</tr>
</tbody>
</table>

Note: * p < 0.05  
** p < 0.01  
DF = Degree of freedom  
R1 = Retention test (1)  
R2 = Retention test (2)  
BT = Benchwork theory (exercise unit stage)  
CT = Classroom teaching (midterm test)  
TD = Technical drawing (exercise unit stage)

Table 5.6  Product moment correlation of four pairs of factors involved with students' performances on study unit topics, at the end of the exercise unit stage.
i) Relationship between retention test (1) and retention test (2)

From the table shown above, it was found that correlation coefficients between retention test (2) and retention test (1) were generally low for many topics across three knowledge groupings (i.e., knowledge gained, knowledge lost, and knowledge gained/lost). This probably implies that there was little impact of the retention test (1) on the retention test (2). Which in turn means that performances of students on retention test (2) were scarcely affected by their knowledge retained from the retention test (1). Much of influence on their performance on the retention test (2) must have been due to a number of extraneous factors and variables. Factors which might have some influence in this case were, for example, regression toward the mean, ceiling effect, and difficulty level of test items.

The many low correlation coefficients of the 'knowledge gained' group (i.e., topics 2, 3, 4, and 5) would be an indication of a suppression effect on difficulty level of test items. Since scores on test items were on the interval scale, students who scored high on the retention test (1) would have tried harder to achieve higher scores on difficult items than those students who scored low on the retention test (1) and achieved higher scores on easier items.

The ceiling effect might be another factor virtually involved in some topics like that on vernier calipers. Reference to this topic in table 5.4, reveals that CC and ACC students achieved on average 88% (5.3 scores out of 6) on the retention test (1). So that, there was little room for some students with a high score to progress even higher on the retention test (2). And this in turn accounts for the low correlation coefficients.

There were three topics on the 'knowledge gained' grouping where retention test (2) correlated significantly the retention test (1), i.e., topics 1, 3 and 5. It implies that retention test (1) still had significant influence on retention test (2). Thus, for many students, their performance on retention test (2) were moderately dependent on their memory or retrieval capability of the knowledge retained from retention test (1).

Low correlation coefficients for topics on the knowledge lost group imply in general that students could not retain their memory
of parts of the knowledge learned or retained in the previous testing. It also implies that the influence of external variables such as experiences of benchwork production exercises and classroom teaching were not strong enough to compensate for the loss of memory.

The students' motivation and curiosity in some topics like topic 6, in particular, probably involves and influences their memory. Ausubel, Novak and Hanesian (1978) pointed out that motivation factors influence retention - by raising thresholds of availability - only on relatively rare instances where retrieval of particular information would be ego-threatening or productive of anxiety. As I pointed out earlier some topics were not used on the current workshop exercises. Then, it might be the case that students simply lost part of their knowledge due to the lack of self-motivation or interest in these topics.

Topic 7 on the knowledge lost group, which was also not used in the current benchwork production exercises, had a statistically significant correlation with the retention test (1). It gives slight indication that parts of students' knowledge on retention test (2) was accounted for by their previous knowledge from retention test (1). The characteristic of this result might be that students with high scores for retention test (1) lost a smaller part of their knowledge on retention test (2) than those who scored lower on retention test (1). This is not because the good students forget at a slower rate, but, because they retained more knowledge in the previous testing. Underwood (1954) pointed out that if the initial level of mastery is held constant, there is no difference in retention between fast and slow learners.

For two topics in the knowledge gained/lost group (i.e., topics 9 and 11) the effect of regression toward the mean might be involved, as indicated by a low or very low correlation coefficient. This phenomenon was discussed in connection with short-term retention. Topic 10 on this group was correlated significantly at a moderate level with retention test (1). Thus student performances on retention test (2) were partly accounted for by their performances on retention test (1).
ii) Relationship between the retention test (2) and classroom teaching, benchwork theory and technical drawing

Reference to Table 5.6 for correlations between the retention test (2) and the classroom teaching (midterm test), shows how a number of low and moderate coefficients were found; and in one occasion (i.e., item 9) there was a perfect correlation. It is very interesting to compare the strength of correlation between topics for the 'knowledge gained' and the 'knowledge lost' groups. There, it was found that all topics of the knowledge gained group, except topic 5, were correlated significantly with the retention test (2), whereas, none were thus found for topics in the knowledge lost group. This sharp contrast indicates that an influence from classroom teaching did exist and also accounted for the increase of students' knowledge on most (4 out of 5) study unit topics in the knowledge gained group, but not at all on those in the knowledge lost group. The division of influence of the classroom teaching on study unit topics is probably due to: (1) the students themselves lacking interest in some topics particularly those of the lost knowledge group, and/or (2) classroom teaching on the topics of the lost knowledge group was ineffective. This could be justified on the basis of the model of learning, presented earlier, and on the situation occurring during training.

As I already pointed out that students knew which tools or instruments there were going to use or were available to them for their exercises. This probably altered students' attention towards those topics which contained knowledge they though of as relevant to the exercises and away from others.

Now, considering the correlations between the retention test (2) of the study unit topics and benchwork theory, it was found that for 8 out of 11 of the study unit topics (see table 5.6) the correlation between these tests were statistically significant. Having compared these results with those found between retention test (2) and the technical drawing shown in the next column of the table, it was found that the latter had only 5 out of 11 topics (see table 5.6) correlated significantly. This means that knowledge of benchwork theory was related more closely than that of technical drawing to knowledge on study unit topics. This is because the areas covered in the benchwork
theory test on a whole were similar to those in each study unit topic, whereas the areas covered in the technical drawing test were not. In this respect, it implies that knowledge of technical drawing did influence student performance on some study unit topics.

As both tests on benchwork theory and technical drawing covered areas required in benchwork production exercises (a small vice), the results of correlational studies above, implicitly imply the influence of experiences gained from benchwork production exercises on students' medium-term retention. However, the present design could not provide the means to determine the degree of its direct impact on the retention of student knowledge, due to the lack of control groups.

5.6 DEVELOPMENT OF STUDENTS' KNOWLEDGE ON BENCHWORK THEORY AND FACTORS AFFECTING THEIR LEARNING

Thus far I have discussed the development of students' knowledge on study unit topics and the factors influencing their retention. In the following sections I will discuss the development of student knowledge on benchwork theory and other factors affecting their progress.

I will present first a number of models of learning this knowledge at various stages of the training and then analyse the results.

a) Development of student learning at the study unit stage

It is probable that incoming students entered into the training system with some knowledge related to both benchwork theory and technical drawing. Their knowledge in this respect will undoubtedly be increased to some extent as result of their studies of the study unit topics given in the study unit stage. As there were 11 topics given in the study unit stage and each topic would require about 60 minutes or more to complete, both CC and ACC students completed all topics within 14 days (counting from the pre-system test until the end of the study unit stage). During this stage both CC and ACC students were allowed equal amounts of time to study, even though CC students had three days per week in this course while ACC students had four days.
In parallel to the workshop training students of both classes also attended a course on metal trade principles (1), taught in a classroom. But, since the classroom teaching was for only two periods a week, there was only one topic, measuring and gauging, given to both classes. In this case I assumed that at this stage there was no effect of the classroom teaching on the changes of student knowledge of both benchwork theory and technical drawing.

The changes in student knowledge of both benchwork theory and technical drawing were hypothesized as being due to the intervention of the studies or lectures given on the 11 study unit topics, student pre-knowledge, the interaction of study unit topics and pre-knowledge and other factors not measured.

The model of learning in the study unit stage for both benchwork theory and technical drawing is depicted in diagram 5.3

![Diagram 5.3 System diagram of student learning in the study unit stage on benchwork theory and technical drawing.](image)

The analysis of factors contributing to student performances at the end of the study unit stage (terminal performances) for both benchwork theory and technical drawing is expressed as being due to:

1. The gross knowledge on study unit topics = \( x \)%
2. The students' pre-knowledge = \( x \)%
3. The interaction between gross knowledge on study unit topics and pre-knowledge = \( x \)%
4. Other factors not measured = \( x \)%

Total = 100 %
b) Development of student learning at the end of the consolidating unit stage

Following the study unit stage, students entered into the practice unit stage and practiced their workshop skills on three basic U-shaped exercises. They had to measure and grade their own finished work as part of their training. Students who had completed all these exercises then continued onto the consolidating unit stage.

Four topics of pictorial programmed quizzes were given in the consolidating unit stage. As students could complete all these programmed quizzes within 1 or 2 days I linked this consolidating unit stage with the practice unit stage. The next test on both benchwork theory and technical drawing were then administered to all students at the same time at the end of the consolidating unit stage. Notice that some students who worked fast were already working on the exercise unit stage for some times before this test was administered.

Student knowledge of both benchwork theory and technical drawing at the end of the consolidating unit stage is regarded as being influenced by four main variables; (1) knowledge previously attained at the end of the study unit, (2) knowledge gained from classroom teaching, (3) knowledge gained from experience on the workshop production exercises, and (4) knowledge gained from pictorial programmed quizzes. The model of learning in this stage is given in Diagram 5.4.

Diagram 5.4 System diagram of student learning on benchwork theory and technical drawing at the end of the consolidating unit stage.
Unfortunately, there were only data available from both the previous testing and the current testing of both benchwork theory and technical drawing. Whereas, other variables could not be measured or obtained at that time. These variables required data on classroom teaching, knowledge gained from workshop experience and knowledge gained from pictorial programmed quizzes.

Within this circumstance the multiple correlation for three variables will be used to analyse the relative contribution of previously attained knowledge of both benchwork theory and technical drawing to the current retained knowledge of benchwork theory and technical drawing. The t-test for correlated data will also be used for testing statistically significant changes of student knowledge.

c) Development of student knowledge at the end of the exercise unit stage

Students continued their training by moving to the exercise unit stage. In this stage, they produced the components of the small vice in three production exercises. In addition, students engaged in the preparation of their own production plan, or sequence of operations, either individually or together with other colleagues. They also measured and graded their own finished products.

In parallel students studied all the topics of part 1 of the classroom teaching. These topics were equivalent to the 11 study unit topics given in the study unit stage.

By the end of the exercise unit stage, all students were tested at the same time with the same tests of benchwork theory and technical drawing. The elapsed time from the previous testing to this one was 35 days.

The current knowledge of students of both benchwork theory and technical drawing at this stage is regarded as being influenced by four main variables: (1) their previously retained knowledge of benchwork theory, (2) their previously retained knowledge of technical drawing, (3) classroom teaching (leading up to the midterm test), and (4) knowledge gained from workshop experiences. The model of students' learning in this stage is depicted in diagram 5.5.
Unfortunately, the data on knowledge gained for experience of workshop production exercises was never measured within the present design. With techniques of multiple correlation, however, an estimate of the degree of its contribution to the current knowledge of benchwork theory and technical drawing could be accomplished indirectly. (That is it was in the form of the other factors not measured).

The analysis of the relative contributions of the above factors to the current knowledge of students is accomplished by means of multiple correlation with four variables. Results of the analysis are expressed as the current performances of students in benchwork theory or technical drawing being due to:

1. Knowledge from classroom teaching = x %
2. Previously attained knowledge on benchwork theory = x %
3. Previously attained knowledge on technical drawing = x %
4. Interaction of 1 and 2 = x %
5. Interaction of 1 and 3 = x %
6. Interaction of 2 and 3 = x %
7. Other factors not measured = x %

Total = 100 %
d) Development of student knowledge at the end of the course

After the exercise unit stage, students continued their training under the traditional training system. In this stage, no specific lesson was given to all students, except a few informal workshop talks given to some fast working students. Students followed the drawings and plans given in the exercise book which was used regularly with this course. No measurement or grading of finished products were carried out as part of their training, except the measurement done during their normal production procedures.

In the same manner as in the first half of the semester, students still attended the classroom teaching as usual. The areas covered in the second half of the semester were topics of part 2. No repetition of topics on part 1 was made.

By the end of the training course the same tests of both benchwork theory and technical drawing were administered to all students at the same time, on the last day of the final examination. The time which had elapsed between the previous testing and this one was 54 days.

Factors affecting the current student knowledge of both benchwork theory and technical drawing in this stage were regarded as: (1) the previously retained knowledge of benchwork theory, (2) the previously retained knowledge of technical drawing, (3) the previously retained knowledge from classroom teaching in part 1, (4) the current knowledge from classroom teaching part 2, and (5) experience gained from workshop practice. The model of student learning in this stage is depicted in diagram 5.6.
With the present design of the training system, there was no measurable data for the experience on workshop practice. The classroom teaching test at the final examination covered all topics in the course, thus measured the total knowledge of the whole course rather than that of part 2 in particular.

As there are five variables involved in this stage, the multiple correlation for more than four factors would become very complicated. I, therefore, divided the analysis into three steps: (1) a normal product moment correlation, (2) multiple regression analysis, and (3) a multiple correlation analysis for four factors. The least relationship revealed in the multiple regression analysis was eliminated in the third step.

Diagram 5.6 System diagram of student learning on benchwork theory and technical drawing at the end of the training course.
5.7 RESULTS ON CHANGES IN STUDENT KNOWLEDGE ON BENCHWORK THEORY

As described in the preceding section, five successive tests of benchwork theory were administered to both CC and ACC students at (1) pre-system stage, (2) the end of study unit stage, (3) the end of consolidating unit stage, (4) the end of exercise unit stage, and (5) the end of the course. The scores for both CC and ACC students on benchwork theory at five successive testings are given in Appendix 5.8a and b.

Performances of both CC and ACC students on the five tests for benchwork theory are plotted in Diagram 5.7, based on their average scores.

Diagram 5.7 Performances of CC and ACC students on benchwork theory at five successive testings of the workshop training course.
Results of the t-test, using the pooled variance formula, for testing statistical significance in the difference on mean scores of the two classes at every test are given in Table 5.7.

Notice that four students from the ACC class were absent on the pre-system test, due to their late registration for the course. One ACC student was ill and finally retired from the course. Also another CC and ACC student were absent on the last test, due to personal reasons.

Based on the results shown in the table, it was found that there were no statistically significant differences between the mean scores of the two classes over the five tests, at a 95% confidence level. That means, both CC and ACC students had on average the same level of pre-knowledge of benchwork theory, and progressed at equal rates throughout the workshop training course.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Class</th>
<th>N</th>
<th>( \bar{X} )</th>
<th>S.D</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pre-system</td>
<td>CC</td>
<td>18</td>
<td>29.7</td>
<td>6.0</td>
<td>1.2</td>
</tr>
<tr>
<td>stage</td>
<td>ACC</td>
<td>16</td>
<td>27.4</td>
<td>5.3</td>
<td></td>
</tr>
<tr>
<td>2. Study unit</td>
<td>CC</td>
<td>18</td>
<td>48.7</td>
<td>4.8</td>
<td>0.1</td>
</tr>
<tr>
<td>stage</td>
<td>ACC</td>
<td>19</td>
<td>48.4</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td>3. Consolidating</td>
<td>CC</td>
<td>18</td>
<td>51.7</td>
<td>5.6</td>
<td>-1.0</td>
</tr>
<tr>
<td>stage</td>
<td>ACC</td>
<td>19</td>
<td>53.7</td>
<td>6.1</td>
<td></td>
</tr>
<tr>
<td>4. Exercise unit</td>
<td>CC</td>
<td>18</td>
<td>54.8</td>
<td>4.8</td>
<td>-1.0</td>
</tr>
<tr>
<td>stage</td>
<td>ACC</td>
<td>19</td>
<td>56.9</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>5. Post-course</td>
<td>CC</td>
<td>17</td>
<td>54.1</td>
<td>4.4</td>
<td>-0.6</td>
</tr>
<tr>
<td>stage</td>
<td>ACC</td>
<td>18</td>
<td>55.2</td>
<td>5.8</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.7 Differences between mean scores of CC and ACC classes on five successive testings on benchwork theory.
Changes in student knowledge of benchwork theory for both CC and ACC students over five successive testings, are given in Table 5.8. Notice that paired data over the five tests were used for testing statistically significant changes.

Based on results given in the table, it was found that students of both classes, on average, progressed significantly throughout the first half of the semester, i.e., from the study unit stage up to the exercise unit stage. But both classes showed a loss of knowledge by the end of the training course. Also a statistically significant loss was found for the ACC class, at 95% confidence level.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Class</th>
<th>N</th>
<th>Previous score</th>
<th>Current score</th>
<th>Difference score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>X  S.D</td>
<td>X  S.D</td>
<td>X  S.D</td>
</tr>
<tr>
<td>T1 to T2</td>
<td>CC</td>
<td>17</td>
<td>29.2 5.8</td>
<td>48.3 4.6</td>
<td>19.1 5.9</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>16</td>
<td>27.4 5.3</td>
<td>48.7 8.3</td>
<td>21.3 5.5</td>
</tr>
<tr>
<td>T2 to T3</td>
<td>CC</td>
<td>17</td>
<td>48.3 4.6</td>
<td>51.3 5.6</td>
<td>3.0 4.3</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>16</td>
<td>48.7 8.3</td>
<td>53.4 6.3</td>
<td>4.7 4.2</td>
</tr>
<tr>
<td>T3 to T4</td>
<td>CC</td>
<td>17</td>
<td>51.3 5.6</td>
<td>54.6 4.8</td>
<td>3.3 3.0</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>16</td>
<td>53.4 6.3</td>
<td>56.9 6.3</td>
<td>3.5 3.2</td>
</tr>
<tr>
<td>T4 to T5</td>
<td>CC</td>
<td>17</td>
<td>54.6 4.8</td>
<td>54.1 4.4</td>
<td>-0.5 3.5</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>16</td>
<td>56.9 6.3</td>
<td>55.3 6.1</td>
<td>-1.6 2.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>T1 = Pre-system stage</th>
<th>T2 = Study unit stage</th>
<th>T3 = Consolidating unit stage</th>
<th>T4 = Exercise unit stage</th>
<th>T5 = Post-course</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Pre-system stage</td>
<td>Study unit stage</td>
<td>Consolidating unit stage</td>
<td>Exercise unit stage</td>
<td>Post-course</td>
</tr>
<tr>
<td>T2</td>
<td>Study unit stage</td>
<td>Consolidating unit stage</td>
<td>Exercise unit stage</td>
<td>Post-course</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>Consolidating unit stage</td>
<td>Exercise unit stage</td>
<td>Post-course</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.8 Gains and losses in student knowledge of benchwork theory over five successive testings in the workshop training course.

Consistent results and statistical significances for gain scores for performances in both classes provide strong evidence of the improvement of student learning in benchwork theory, based on the model of learning at the various training stages, the results imply that there was an impact of the variables concerned on knowledge of students and that this impact on the whole was greater than the probability associated with students loss of retention. However,
it is not clear at this stage what is the relative influence on student development at each stage. The multiple correlation to be carried out in the next step aims to provide this information.

The consistent results on the loss of knowledge in students in both classes and the statistical significance on the loss in ACC students, give enough evidence to indicate students' forgetting on benchwork theory. The multiple correlation analysis into the system interaction at this stage of the training will reveal areas of strength and weakness in terms of their relative contributions to the current knowledge of students.

1. Knowledge gained on benchwork theory at the end of the study unit stage

In the model of learning in the study unit stage, the three main variables consisted of student pre-knowledge of benchwork theory (as measured by test T1), the total knowledge of study unit topics (abbreviated by SU) and the current obtained knowledge of benchwork theory (measured by the same test as T1 but abbreviated by T2). As a first step to determine the relative contribution of T1 and SU to T2 a product moment correlation between them was carried out. Table 5.9 shows the results of the correlation among these variables. Notice that the data used were from 36 CC and ACC students.

<table>
<thead>
<tr>
<th>DF = 34</th>
<th>T2</th>
<th>SU</th>
</tr>
</thead>
<tbody>
<tr>
<td>SU</td>
<td>0.77**</td>
<td>0.43**</td>
</tr>
<tr>
<td>T1</td>
<td>0.59**</td>
<td></td>
</tr>
</tbody>
</table>

** p<0.01

Table 5.9 Intercorrelation of the three variables involved in the study unit stage for 36 CC and ACC students on benchwork theory.

From the table it was found that relationships between pre-knowledge (T1) and a gross knowledge on study unit topics (SU), and the current knowledge on benchwork theory (T2) were at moderate level, i.e., 0.59 and 0.43 respectively, while the correlation between the total knowledge of study unit topics (SU) and the current knowledge
on benchwork theory (T2) was at high level (0.77). These correlation coefficients were statistically significant. This provides strong evidence to conclude that there were relationships between pre-knowledge, the total knowledge of study unit topics and the current knowledge of benchwork theory. Based on the model of the learning in diagram 5.3 then, these results imply that students' pre-knowledge influences to some extent both the total knowledge of study unit topics and the current knowledge of benchwork theory. Subsequently the total knowledge of study unit topics facilitates the improvement of student knowledge at the end of the study unit stage.

The degree of contribution of pre-knowledge, total knowledge of benchwork theory, their interaction, and other factors not measured to the current knowledge of students about benchwork theory was determined by multiple correlation analysis. The result of this analysis is given in table 5.10.

<table>
<thead>
<tr>
<th>The current knowledge of students on benchwork theory at the study unit stage was due to ....</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pre-knowledge of benchwork theory</td>
<td>9.5 %</td>
</tr>
<tr>
<td>2. Total knowledge of study unit topics</td>
<td>41.1 %</td>
</tr>
<tr>
<td>3. Interaction of 1 and 2 above</td>
<td>17.1 %</td>
</tr>
<tr>
<td>4. Other factors not measured here</td>
<td>32.3 %</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0 %</strong></td>
</tr>
</tbody>
</table>

Table 5.10. Relative contributions of the variables involved at the study unit stage on students' knowledge on benchwork theory.

The result above indicates that the contribution of pre-knowledge to the current knowledge of benchwork theory was very low.

---

1. For the purpose of interpretation five levels of contribution of variables in multiple correlation analysis is arbitrary set up as follows: 100-90% = very high, 90-70% = high, 70-40% = moderate, 40-20% = low, and 20-0% = very low.
(i.e., about 10%), whereas that of total knowledge of study unit topics was moderate (41%), and of their interaction was low (17%).

For this part of information it is sufficient to state that the present arrangement of the training system and study unit topics on the whole was satisfactory. This is so because (1) the training system did not require much of the students' pre-knowledge and, (2) knowledge on study unit topics had moderate impact on students' current knowledge. Any programme or system which required a lot of pre-knowledge would be troublesome if the incoming students had low level of pre-knowledge.

However, observing the percentage contribution due to other factors not measured here, indicates that the figure was quite high. It is not clear at this stage of what factors are included in this item. It might contain knowledge gained from experience on practical exercises given in each study unit topic, or knowledge from other related subjects, or educated guessing. If it were the first of these then the result would be desirable, but others would not, as they could not be controlled within the scope of the model.

With respect to this outcome and the average achievement of both CC and ACC students as regards knowledge at the end of the study unit stage (see diagram 5.7), there is room to improve either the percentage contribution of total knowledge of study unit topics and the average achievement of students on benchwork theory. The possibilities might exist for improving the quality of each individual study unit topic and its practical exercises, and guidance as well as encouragement to the students.

2) Knowledge gained on benchwork theory at the end of the consolidating unit stage

In the model of learning at the end of the consolidating unit stage, the pattern of analysis as used in the preceding section is again being used in this stage. The three variables which were measured are: the previously retained knowledge of benchwork theory (T2), and of technical drawing (T2.TD), and the current knowledge on benchwork theory (T3). Product moment correlations for these variables are given in Table 5.11. Notice that the data used were based on the scores of 36 CC and ACC students.
The results above indicated that relationships among these variables were at moderate and high levels, and were also statistically significant. Within the context of the model of learning it means that there was a statistically significant relationship between the previously retained knowledge of benchwork theory (T2) and that of technical drawing (T2 TD). The presence of both areas of knowledge had a statistically significant influence on the current knowledge of benchwork theory (T3). However the influence of the previously retained knowledge of benchwork theory was stronger than that of technical drawing, as revealed by the higher correlation coefficient (0.78) of the former compared with that of the latter (0.51). This is because T2 and T3 were administered with the same test.

The relative contribution of the previously retained knowledge of benchwork theory and of technical drawing, and other factors not measured to the current knowledge of benchwork theory is given in Table 5.12.

<table>
<thead>
<tr>
<th>The current performance on benchwork theory of CC and ACC students at the end of consolidating unit stage was due to ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Previously attained knowledge of benchwork theory = 53.8 %</td>
</tr>
<tr>
<td>2. Previously attained knowledge of technical drawing = 0.5 %</td>
</tr>
<tr>
<td>3. Interaction between 1 and 2 above = 6.3 %</td>
</tr>
<tr>
<td>4. Other factors not measured = 39.4 %</td>
</tr>
<tr>
<td>Total = 100.0 %</td>
</tr>
</tbody>
</table>

Table 5.12 Relative contribution of variables involved in the current knowledge of CC and ACC students of benchwork theory at the end of the consolidating unit stage.
I shall recall for a moment the degree of knowledge gained at the end of the consolidating unit stage (see Table 5.8). There, students of both CC and ACC classes on average had improved about 4 scores (or 8% of the previously retained knowledge) from the previous test to the current test. Now if there was no training given after the previous testing, it is conceivable that students might have lost some part of this knowledge due to forgetting and then a lower score would be found for almost every student. With this notion, it can be recognized that all the activities students had engaged on in this stage would yield a result in two steps. First, it must compensate for the knowledge lost by forgetting and then increase that knowledge to a higher level. But since there was no control group available in my design, the amount of knowledge due to forgetting as in the case of no training could not be determined.

Now I come back to the results shown in the above table. It was found that 54% of the contribution was from the previously retained knowledge of benchwork theory, only 0.5% from technical drawing, and 6.3% from their interaction. This part of the results implies that the previously retained knowledge of technical drawing contributed almost nothing to the current knowledge of benchwork theory. This is probably due to there being no lesson given in technical drawing in the previous stage or any stage in this course, and thus students' knowledge on this was very low indeed. In other words, there was insufficient knowledge of technical drawing to contribute to the current knowledge on benchwork theory (see student performances in technical drawing in table 5.18). The reason for a high degree of contribution from the previously retained knowledge of benchwork theory would be students having a good memory, or possibly the practice effect on this test, since this was the third time the students had done it.

Next, the contribution from other factors not measured was found to be 39%. This is quite high in relation to the contribution from the previously retained knowledge of benchwork theory. Factors involved in this item might be mainly the knowledge from classroom teaching part (1) and experiences gained from workshop exercises.
A high contribution from 'other factors not measured' in this stage was more desirable than that from the previously retained knowledge of benchwork theory. This is because a good training system should give more useful knowledge out of activities provided during the training. Too high a contribution from the previously retained knowledge in fact indicates a rote learning which is undesirable for students of this level.

Other possibilities of enhancing the knowledge obtained during the training should be emphasized and built into workshop exercises as a part of student training. This could be achieved in a number of ways such as homework assignments on some techniques or problems involved in workshop operations, group discussion in the last period of each week on many aspects concerned in workshop operations, etc. But most of all students should be encouraged to work and study up to their limits. The results shown at this stage, thus far, still indicate the lack of students working to their own limits, as can be seen from the average achievement on the benchwork theory test.

3). Knowledge gained on benchwork theory at the end of the exercise unit stage

Following the same procedures as in the preceding sections the results in Table 5.13 indicate correlation coefficients for the variables concerned in the exercise unit stage. These variables are: the current knowledge on benchwork theory (T4), previously attained knowledge on benchwork theory (T3), previously attained knowledge on technical drawing (T3.TD), and the current knowledge from classroom teaching (CT1).

<table>
<thead>
<tr>
<th></th>
<th>T4</th>
<th>T3</th>
<th>T3.TD</th>
</tr>
</thead>
<tbody>
<tr>
<td>T3</td>
<td>0.86**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3.TD</td>
<td>0.46**</td>
<td>0.50**</td>
<td></td>
</tr>
<tr>
<td>CT1</td>
<td>0.66**</td>
<td>0.73**</td>
<td>0.52**</td>
</tr>
</tbody>
</table>

\* p < 0.01

Table 5.13 Intercorrelation among four variables involved at the end of the exercise unit stage for performances of 36 CC and ACC students on benchwork theory.
The results shown above indicate correlations among variables concerned at moderate and high levels. All coefficients were found to be statistically significant at 99% confidence level. This means that there were relationships between the previously retained knowledge of benchwork theory (T3), that of technical drawing (T3.TD), and that from classroom teaching Part 1 (CT1). Based on the model of learning at this stage the correlations indicated that previously retained knowledge of both benchwork theory and technical drawing had a statistically significant influence on the current knowledge on benchwork theory. In addition, knowledge on classroom teaching Part 1 also had a statistically significant influence on the current knowledge on benchwork theory.

The relative contributions of all the variables concerned to the current knowledge on benchwork theory are given in Table 5.14.

<table>
<thead>
<tr>
<th>The current performance of students on benchwork theory at the end of the exercise unit stage was due to....</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Previously attained knowledge of benchwork theory = 62.8 %</td>
</tr>
<tr>
<td>2. Previously attained knowledge of technical drawing = 0.1 %</td>
</tr>
<tr>
<td>3. Current knowledge from classroom teaching = 0.5 %</td>
</tr>
<tr>
<td>4. Interaction of 1 and 2 = 2.3 %</td>
</tr>
<tr>
<td>5. Interaction of 1 and 3 = 7.8 %</td>
</tr>
<tr>
<td>6. Interaction of 2 and 3 = 0.2 %</td>
</tr>
<tr>
<td>7. Other factors not measured = 26.3 %</td>
</tr>
<tr>
<td><strong>Total = 100.0 %</strong></td>
</tr>
</tbody>
</table>

Table 5.14. Relative contribution of variables concerned on students' knowledge of benchwork theory at the end of the exercise unit stage.

The current performance on benchwork theory of CC and ACC students on average had shown statistically significant improvement for about 3 scores (or 6.5% or the previously retained knowledge on benchwork theory). This current knowledge was very much dependent (62.8%) on the previously retained knowledge of benchwork theory. This indicates that students had a very good memory for this area of
knowledge. This could be explained as partly due to the practice effect on this test.

Contributions both from previously retained knowledge of technical drawing and from classroom teaching were insignificant (i.e., 0.1% and 0.5% respectively). The interactions between these and with the previously retained knowledge of benchwork theory were also very low, ranging from 0.2 to 7.8%. This could probably be explained as being due to (1) students having insufficient knowledge of technical drawing (see results in T4 in Table 5.18), (2) knowledge learned in the classroom teaching being insufficient or unrelated in terms of practical use for the workshop. The material given in the classroom was usually based on a theoretical orientation whereas those in workshop practice required a practical one.

Still another contribution was from the other factors not measured. Its contribution was considered to moderate (26%) in relation to that of the previously retained knowledge of benchwork theory (63%). Factors involved here might consist mainly of the knowledge gained from the experience and activities of workshop operation. This interpretation is based on the model of the learning of this stage.

However, if the contribution from the other factors not measured was viewed in isolation from others, its contribution was at a low level. It would be desirable in the operation to have a larger contribution from this item. And in the future, if there were a number of lessons given on technical drawing together with the improvement in the teaching in the classroom, there should be a lower percentage contribution from the previously retained knowledge of benchwork knowledge (i.e., item 1), and a higher contribution from technical drawing (item 2), classroom teaching and their interaction. Thus, a higher gained score would be obtained than at present.

4). Lost knowledge of benchwork theory at the end of the course

From the results of the benchwork theory test at the end of the training course, losses of students' knowledge were found for both classes (see Table 5.8).

According to the model of learning at this stage, (see Diagram 5.6, five variables were involved including student performance at benchwork theory at the end of the course (i.e. T5). The other four
variables were: (1) previously retained knowledge of benchwork theory (T4), (2) previously retained knowledge of technical drawing (T4.TD), (3) previously retained knowledge from classroom teaching (CT1), and (4) the current knowledge from classroom teaching (CT2). Notice that the test on CT2 covered all topics taught in the metal trade principles (1) course, i.e., both part 1 and part 2. The measure thus determined a total knowledge of metal trade principles (1) as a whole rather than a specific knowledge of part 2.

A correlational matrix for these five variables is given in Table 5.15. It was found that all variables were correlated to each other at moderate and high levels, and all showed statistically significant relationships.

<table>
<thead>
<tr>
<th></th>
<th>T5</th>
<th>T4</th>
<th>T4.TD</th>
<th>CT1</th>
</tr>
</thead>
<tbody>
<tr>
<td>T4</td>
<td>0.82*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T4.TD</td>
<td>0.65*</td>
<td>0.66*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT1</td>
<td>0.61*</td>
<td>0.68*</td>
<td>0.57*</td>
<td></td>
</tr>
<tr>
<td>CT2</td>
<td>0.41*</td>
<td>0.43*</td>
<td>0.44*</td>
<td>0.71*</td>
</tr>
</tbody>
</table>

* p < 0.05  ** p < 0.01

Table 5.15 Correlation matrix on five variables for 35 CC and ACC students at the end of the training course.

The results above imply that all four variables had influenced to some extent the current knowledge of students of benchwork theory. But since students' knowledge declined by about 1 mark on the previous testing see Diagram 5.7, it means that the rate of forgetting by students was higher than the rate of improvement or new learning by them. Even though the loss was only slight, but it was statistically significant for the ACC class. Above all, I would think, students should have improved their knowledge even more since the previous testing. In this respect, I would consider this loss as having educational significance.
Multiple correlation analysis to be applied on the above correlational matrix would reveal the relative contributions of the variables concerned and thereby any weak components of the training system could be identified. Since here there are five variables to be studied, the multiple correlation analysis would be difficult to calculate. Therefore, I will eliminate one variable which had the least influence in the system. The multiple regression analysis for five variables is used in this case.

Multiple regression analysis is used to predict the performance of students in current knowledge of benchwork theory, by using other variables as predictors. The relationship among the variables is expressed as:

\[ T_5 = f (T_4, T_4.TD, CT_1, CT_2) \]

and the equation used in this case is:

\[ T'_5 = 17.6 + 0.59T_4^* + 0.197T_4.TD + 0.038 CT_1 + 0.003 CT_2 \]

Where \( T'_5 \) = predicted score for current knowledge of benchwork theory.

The adjusted \( R^2 \) for this equation is 65.1. The results given in Table 5.16 show that current knowledge of benchwork theory is significantly influenced by the previously retained knowledge of benchwork theory, but not be for the rest.

The results on multiple regression analysis indicated that students' performance in the final examination on classroom teaching (CT2) is the factor with least influence of all. I, therefore, eliminated it from the multiple correlation analysis.

The result on relative contributions of previously attained knowledge of benchwork theory and technical drawing and classroom teaching given in table 5.17.

* indicates that the coefficient is significantly different from zero, at the 95% confidence level.
### Table 5.16 Results of multiple correlation analysis on benchwork theory at the end of the course.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient of raw score</th>
<th>S.D of raw score</th>
<th>t-ratio coef./S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equation: Current knowledge on benchwork theory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. retained knowledge on benchwork theory</td>
<td>0.590</td>
<td>0.14</td>
<td>4.17*</td>
</tr>
<tr>
<td>2. retained knowledge on technical drawing</td>
<td>0.197</td>
<td>0.14</td>
<td>1.39</td>
</tr>
<tr>
<td>3. classroom teaching (1)</td>
<td>0.038</td>
<td>0.12</td>
<td>0.31</td>
</tr>
<tr>
<td>4. Classroom teaching (2)</td>
<td>0.003</td>
<td>0.06</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Multiple correlation = 0.83  
Adjusted $R^2$ = 65.1  
Degree of freedom = 30  
* p < 0.05

Performance on the current knowledge on benchwork theory was due to ......

<table>
<thead>
<tr>
<th>Performance</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Previously attained knowledge of benchwork theory</td>
<td>42.5 %</td>
</tr>
<tr>
<td>2. Previously attained knowledge of tech. drawing</td>
<td>3.8 %</td>
</tr>
<tr>
<td>3. Previously attained knowledge of classroom teach.</td>
<td>0.4 %</td>
</tr>
<tr>
<td>4. Interaction of 1 and 2</td>
<td>16.7 %</td>
</tr>
<tr>
<td>5. Interaction of 1 and 3</td>
<td>5.4 %</td>
</tr>
<tr>
<td>6. Interaction of 2 and 3</td>
<td>1.4 %</td>
</tr>
<tr>
<td>7. Other factors not measured here</td>
<td>29.9 %</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0 %</strong></td>
</tr>
</tbody>
</table>

Table 5.17 Relative contributions of variables involved in students' performance on benchwork theory at the end of the training course.
From the result above a 43\% contribution the largest - comes from the previously retained knowledge of benchwork theory. Its contribution was lower than ever before. This means that by this stage students had forgotten a lot. A 4\% contribution came from previously retained knowledge of technical drawing. Its contribution had increased since the previous test. This also corresponded to an increase in the students' average achievement (see Table 5.18). Yet the contribution was still at a very low level. This is probably due to students' knowledge of technical drawing not being fully developed. However, its interaction with previously retained knowledge of benchwork theory was higher (ie., 16.7\%). This gives it merit within the system. The contribution from previously retained knowledge of classroom teaching was nearly zero. This result was consistent with that previously found at the end of the exercise unit stage. This confirms the lack of support from classroom teaching part 1 on current knowledge of benchwork theory. Its interactions with previously retained knowledge of benchwork theory and technical drawing were also at very low level, ie., 5.4\% and 1.4\% respectively. The contribution from the other factors not measured was about 30\% which was as high as that from previously retained knowledge of benchwork theory. It is conceivable that the main factor involved in this item was knowledge gained from experience of workshop operations. Of course, this contribution included knowledge from classroom teaching part 2, which contributed the least of all, as shown in the multiple regression analysis discussed previously.

As it is desirable to identify any weak components in the system, this analysis provides a description displaying the information required. From the table above, the weak components of the system are:

1) Classroom teaching practice Parts 1 and 2.
2) Technical drawing.

Possible causes of the lack of contribution from knowledge of classroom teaching might (in my personal understanding) be:

1) The areas covered in part 2 of the metal trade principles (1) were not related to those covered in the study unit programmed texts. This is because the former were concerned with other manufacturing processes such as scraping, drilling.
reaming etc., whereas the latter with measuring, clamping
scribing and filing.

2. The ability to learn and apply the newly learned knowledge of students was different.

3. The ability to recall the previously learned knowledge of students was different.

The low contribution from technical drawing might have been due to the low level of student knowledge in this area. A number of study unit topics must be provided in the same way as for benchwork theory. Additional assignments on the application and integration of knowledge of both benchwork theory and technical drawing need to be included in the training, provided that this would not diminish the number of hours dedicated to workshop practice.

5.8 DEVELOPMENT OF STUDENTS' KNOWLEDGE OF TECHNICAL DRAWING

Technical drawing is one area of workshop knowledge stated in the training specification. Since there was no time available for producing study unit topics on technical drawing, students simply learned about it through their workshop production exercises, or recalled previous knowledge.

Test results on technical drawing part 2 only for both CC and ACC students over five successive testings are given in Table 5.18. These tests were administered at the pre-system stage (T1) the end of the study unit stage (T2), the end of consolidating unit stage (T3), the end of the exercise unit stage (T4) and the end of the training course (T5).
Table 5.18 Performances of CC and ACC students on technical drawing from the beginning until the end of the course.

<table>
<thead>
<tr>
<th></th>
<th>CC</th>
<th>ACC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score</td>
<td>16.5</td>
<td>16.8</td>
</tr>
<tr>
<td></td>
<td>20.3</td>
<td>21.6</td>
</tr>
<tr>
<td></td>
<td>19.7</td>
<td>24.8</td>
</tr>
<tr>
<td></td>
<td>28.1</td>
<td>34.2</td>
</tr>
<tr>
<td></td>
<td>31.0</td>
<td>32.9</td>
</tr>
</tbody>
</table>

Table 5.18 shows the difference scores of CC and ACC students in technical drawing over the five successive testings. The size of the difference scores indicates the rate of growth of knowledge, and the sign indicates whether it is a positive or negative growth.
<table>
<thead>
<tr>
<th>Stage</th>
<th>Class</th>
<th>N</th>
<th>Previous score</th>
<th>Current score</th>
<th>Difference score</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>X   S.D</td>
<td>X   S.D</td>
<td>X   S.D</td>
<td></td>
</tr>
<tr>
<td>1. T1 to T2</td>
<td>CC</td>
<td>16</td>
<td>5.2  4.3</td>
<td>6.3  4.9</td>
<td>1.1  3.8</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>16</td>
<td>5.2  4.1</td>
<td>6.5  5.1</td>
<td>1.3  4.8</td>
<td>1.1</td>
</tr>
<tr>
<td>2. T2 to T3</td>
<td>CC</td>
<td>16</td>
<td>6.3  4.9</td>
<td>6.1  4.6</td>
<td>-0.2  3.5</td>
<td>-0.2</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>16</td>
<td>6.5  5.1</td>
<td>7.8  4.9</td>
<td>1.3  4.5</td>
<td>1.2</td>
</tr>
<tr>
<td>3. T3 to T4</td>
<td>CC</td>
<td>16</td>
<td>6.1  4.6</td>
<td>8.8  3.6</td>
<td>2.7  3.6</td>
<td>3.0**</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>16</td>
<td>7.8  4.9</td>
<td>11.1 5.9</td>
<td>3.3  3.0</td>
<td>4.4**</td>
</tr>
<tr>
<td>4. T4 to T5</td>
<td>CC</td>
<td>16</td>
<td>8.8  3.6</td>
<td>9.7  4.7</td>
<td>0.8  3.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>16</td>
<td>11.1 5.9</td>
<td>10.3 5.6</td>
<td>-0.9  3.0</td>
<td>-1.2</td>
</tr>
</tbody>
</table>

T1 = Pre-system test          T4 = Exercise unit stage test
T2 = Study unit stage test    T5 = Post-course test
T3 = Consolidating unit stage test  ** p <0.01

Table 5.19 Difference scores of CC and ACC students on technical drawing over five successive testings.

The table indicates a constant growth in students knowledge of technical drawing, except at stage 2 for the CC class and at stage 4 for the ACC class. On one occasion (i.e., stage 3) both classes exhibited a statistically significant growth, at 99% confidence level, while other stages did not. This could most likely be explained as being due to experience gained from a number of workshop exercises and from planning a sequence of operations. This assertion could be justified on the grounds that without knowledge of technical drawing students could hardly plan a sequence of operations. Students had to deal with a number of drawings given in exercise unit stages and grading sheets. Production exercises given in the practice unit stage contained simple drawing presented in isometric and projection views, whereas in the exercise unit stage all drawings were given in projection views. Production steps involved in the exercises of the
exercise unit stage were more difficult and contained more working steps. These factors probably account for the statistically significant increase in student knowledge of technical drawing by the end of the exercise unit stage.

However, the rate of growth of this knowledge in students in the present system was in general insufficient. Formal lessons need to be provided for students throughout the training system, and task enrichment should also be provided.

Other factors, apart from the lack of formal lessons, which might also account for the low achievement in technical drawing, are the difficulty of test items and the material covered in the test.

Having considered the table of specifications for this test (see Appendix C2) I would say that these test items were not difficult since 79% of this test was on knowledge and comprehension level, whereas on 21% of the test (3 items) referred to application and analysis.

The student response plot for both classes in this test, given in Appendix E3, indicates that the majority of students failed every item of part 2, except items B7a, B7c, and B8. The ratio \( \bar{x}/K \) or the average achievement of those items were below 0.7 which was arbitrarily set up as the minimum level for acceptance.

The following are areas where students found difficulty in technical drawing.

i) Knowledge of codes and symbols for machine parts, materials and tolerances (i.e., items B1, B2, B3, B4 and B7a).

ii) Knowledge of drawing projection views from given assembly views (i.e., items B5 and B6).

iii) Knowledge of planning a sequence of operations (i.e., item B9).

From the above summary of student difficulties, I would make the following comments on each aspect.

Firstly, every item concerning the codes and symbols for machine parts, materials, and tolerances requires simple factual knowledge. Ability to recall or recognize parts of this information would be sufficient to prove the possession of the required knowledge. The failure on this aspect indicated that students learned them neither in the previous semester nor in this second semester. Students them-
selves showed a lack of self-motivation and enthusiasm to learn by themselves. Students must have realised their weakness on this aspect from a number of successive testings. And there were also questions in the report assignment for every production workshop exercise. Unfortunately, there is no information on how students carried out their report assignments, or the impact of this activity on their workshop knowledge in general.

Secondly, the failure of students to draw projection views from the given assembly view reflected the inadequacy of their current fundamental perception skill in mechanical drawing. But it does not mean that teaching-learning of this subject in the previous semester was deficient. On the contrary, student knowledge on this part was high, as can be seen from a high index of average achievement ($\bar{x}/K$) for the test items of part 1 in the previous student response plot. Rather the experience in interpreting drawings given in production exercises were insufficient to bring about on ability to draw projection views from the given assembly views. In order to overcome this deficiency a formal lesson needs to be provided in a course parallel to the workshop training. Alternatively additional study unit topics and homework assignments could be given to students during training.

Finally, planning a sequence of operations demands both intellectual skill and experience. The short period of involvement in this task as provided during the exercise unit stage proved to be insufficient. This is because this exercise given in that stage were simple and students had this experience on only three occasions. The treatment given at that time was just sufficient for students to prepare plans. If this ability is to be mastered at the end of the course, self-planning of sequences of operations need to be emphasized and implemented immediately after the end of the consolidating unit stage.

5.9 SUMMARY OF RESULTS

The following are a summary of results on the development of student knowledge of both CC and ACC students in the study unit stage, benchwork theory, and technical drawing.

There were 11 study unit topics given in the study unit stage. In the learning stage (i.e., study unit stage), five topics were
analysed. It was found that all students increased their knowledge of all topics significantly. In short-term retention, both gains and loses were found in some topics, whereas others showed either only gains or only loses. In medium-term retention, it was found that some of the study unit topics which were not used in workshop exercises in the first half of the semester showed losses for both classes. On the other hand only a few study unit topics of knowledge used was found either gains or losses. No statistically significant differences were found between the mean scores of CC and ACC students on study unit topics in any occasion.

Generally, correlations between the final knowledge attained on study unit topics and classroom teaching Part 1, ranged from very low to moderate level (i.e., from 0.1 to 0.52), in one occasion a perfect correlation was found. 6 out of 11 study unit topics showed statistically significant relationships with the total knowledge from classroom teaching Part 1.

8 out of 11 study unit topics correlated significantly with the total knowledge of benchwork theory at the end of the exercise unit stage, whereas 5 out of 11 study unit topics with knowledge of technical drawing. The strength of relationship between study unit topics and benchwork theory ranged from 0.2 to 0.66, and between study unit topics and technical drawing from 0.15 to 0.57.

Development of students' knowledge of benchwork theory improved significantly from 29 to 49 marks as a result of the students studying the study unit topics in the study unit stage. A steady improvement of 3 to 4 marks continued from the study unit stage until the end of the exercise unit stage. A slight drop of about 1 mark was found by the end of the course, but this was found to be statistically significant for the ACC class. However, there were no statistically significant differences on any occasion between the mean scores on benchwork theory for the two classes.

The development of student knowledge in technical drawing was very low and thought to be insufficient. This was due to no formal lessons in this area being given during training. Students knowledge of technical drawing gradually increased as a result of experience of workshop training. A statistically significant improvement was found in both classes at the end of the exercise unit stage, yet it was still of a low level. Student difficulties with technical drawing
were found in the area of codes and symbols for machine parts, materials, tolerances, in drawing projection views from an assembly drawing, and in planning sequences of operations. No statistically significant differences were found between the mean scores of the two classes in any test.

Knowledge of technical drawing, and from classroom teaching Part 1 and Part 2 were found to be correlated significantly with the knowledge of benchwork theory at every stage of the training. But all of them were found to lack any strong influence on the development of student knowledge of benchwork theory. One factor which showed a relatively important influence was experience from workshop operations and activities.
6.1 OVERVIEW

As described in the design and construction of the system (Chapter 3), that the main aim of the benchwork skill training course is aimed at students capable of producing a small vice. Within the scope of my research, three components of the small vice assigned in the exercise unit stage as the main tasks of students. Prior to the exercise unit stage, students had been practicing their skills during the first study unit stage on some short, discrete practical exercises, and during the second practice unit stage on the U-shaped work. The third consolidating unit stage had no practical exercises, but pictorial quizzes of techniques used in those skill operations.

In addition to producing qualified work students were required to measure and grade their finished products, and write a report about them. As they proceeded into the exercise unit stage, they were asked to draft their own operation plans either individually or in conjunction with others prior to production. On the majority of occasions teacher was able to provide immediate feedback to students by individual discussion.

During training students selected their own sequence of works by consulting with the network diagram provided. They progressed at their own pace and were allowed to work during breaks or during overtime, but they had to complete the work within the total time proposed for each task.

Another feature of the training is the increment in accuracy of work. It was increased to some extent in both the practice unit and exercise unit stage. Table 6.1 indicates the accuracy of tasks as well as tests and quality specifications of which an analysis will be given later.
### Table 6.1 The accuracy of tasks as classified in terms of quality specifications.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Surface level</th>
<th>Surface finish</th>
<th>Squareness</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 2</td>
<td>+0.2</td>
<td>1.6 µ</td>
<td>+0.2</td>
<td>-</td>
</tr>
<tr>
<td>PU 1</td>
<td>+0.2</td>
<td>-</td>
<td>-</td>
<td>± 0.25</td>
</tr>
<tr>
<td>PU 2</td>
<td>+0.1</td>
<td>-</td>
<td>+0.1</td>
<td>± 0.15</td>
</tr>
<tr>
<td>PU 3</td>
<td>+0.05</td>
<td>1.6 µ</td>
<td>+0.05</td>
<td>± 0.1</td>
</tr>
<tr>
<td>EX 1</td>
<td>+0.05</td>
<td>0.8 µ</td>
<td>+0.05</td>
<td>± 0.1</td>
</tr>
<tr>
<td>EX 2</td>
<td>+0.05</td>
<td>0.8 µ</td>
<td>+0.05</td>
<td>± 0.1</td>
</tr>
<tr>
<td>EX 3</td>
<td>+0.05</td>
<td>0.8 µ</td>
<td>+0.05</td>
<td>± 0.1</td>
</tr>
<tr>
<td>Test 3</td>
<td>+0.05</td>
<td>0.8 µ</td>
<td>+0.05</td>
<td>± 0.1</td>
</tr>
</tbody>
</table>

6.2 **AIMS OF THE EVALUATION**

Within the framework of my training approach, the achievement of students might be affected by many other factors (Singer, 1975), such as the involvement of the teacher, student progress, student aspiration, workshop knowledge, physical strengths, tools and instruments used, etc.

Evaluation of my training approach was thus divided into 3 sections:

- development of student skills,
- differences in achievement between CC and ACC students,
- the impact of the factors affecting students and their achievement.
Each will be discussed separately in subsequent order.

6.3 DESIGN OF THE STUDY

The design of the study was limited by four main factors, the small number of intact students (ACC = 20, CC = 18), the difference in numbers of training per week, the time available in the course, and the readiness of the teachers involved.

To demonstrate the impact of my training approach on student achievement, therefore, I was responsible for the whole ACC class, and two regular workshop teachers for the CC class. This design was lacking in absolute control of impact due to the difference in the numbers training per week in the classes.

The effectiveness of each training stage could not be determined by eliminating or manipulating the position of any stage, because of the small number of students. Therefore, the one-shot model was used in my research. The number of tests were also affected by the limited time available in the course. Three tests, however, were administered at the pre-study unit stage, post-study unit stage and post-exercise unit stage.

6.4 MEASUREMENTS

Reeds (1968) mentioned five aspects which differentiate the performance of a skilled person from that of a beginner:

1. The end result of the skill activity.
2. The consistency in achieving the end result.
3. The operating time.
4. The gracefulness of the operation.
5. The need for cues or feedback.

For benchwork skills the end result can be measured readily on the finished work and operating time recorded. Gracefulness and the need of cues, on the other hand, need to be measured by observation during performance. However, my approach to observation looked for correctness of performance in using tools, hand movements, etc., rather than gracefulness and the frequency of cues needed.

There was one constraint, however, in constructing the test for measuring the end result, i.e., the readiness of students. It is
conceivable that a beginner will not be able to produce a component of machine parts at the very beginning of training. Therefore, the three tests mentioned previously were differed from each other depending on the content and accuracy of the tasks involved in each stage of the training. The following are details of these tests.

6.4.1 THE PRE-STUDY UNIT STAGE TEST

The first workshop test was conducted in seven testing stations, and measured a specific skill, i.e., scribing (layout), sawing, filing, chiselling, scraping, dieing (thread-cutting) and drilling. Other skills were not included due to limited time, and manpower. This test was administered in the workshop, one day after students had prepared their tools and bench. In each testing station a student (or a group of 4-5 students in some testing stations) had to demonstrate his performance in accordance with a number of operations given on the test sheet under the close supervision of a teacher. If a student did not know what to do he would be told what to do (not how to do it) and thus he could attempt all the operations. Performance was judged as 'right' or 'wrong' and a list of observations was made. Examples of a test sheet and an observation sheet are given in Appendices C6 and C11.

This test was completed within 3 hours. The reliability of the test was not determined as only one judge was used in each testing station. However, the data obtained are thought of to some extent reliable due to 3 reasons:

1. Students were asked to stay at least 3 meters away from each testing station and they were called in when asked and then sent to the next station.

2. Skills were difficult to learn or master within a short time.

3. Variation of judging scale was very small and the observation sheet was easy to use for a skillful teacher.
In the second workshop test, administered two days after the end of the study unit stage, each student was required to produce an incomplete piece of work according to the given drawing and operation, (see an example in Appendix C7). An uncompleted task in this case would leave traces of the student's performance at it, which otherwise would be lost in a completed piece of work. This test consisted of four tasks: filing a flat surface, filing parallel surfaces, sawing a square shoulder, and scribing and mark-punching. Chiselling and measuring with a universal bevel protractor and a dial indicator were not included due to insufficient tools being available. In this test every student was asked to grade his finished work according to a given grading sheet (see an example in Appendix C12).

The observation sheet (see Appendix C10) which was proposed for use caused us many difficulties and completion was abandoned for the following reasons.

1. There was no practice in using it.
2. There were no details of descriptions.
3. There were too many observation sheets to handle, because each was to be used for one student.
4. There were so many points to be observed for each item that the time taken would be too long.

Teachers' notes of student mistakes were suggested as an alternative to the observation sheet. In this case unsystematic data was obtained.

Measurement of student tasks was graded by myself and a workshop teacher, using the same grading sheet as the one given to students. Each quality item was graded on a 3 point scale (i.e., X = within the tolerance, I = outside the tolerance but not more than 2 times, and 0 = outside the tolerance and beyond 2 times). Qualities of finished works were measured with acceptable standard measuring instruments. The reliability coefficient of two judges was 0.96 as computed with the Spearman-Brown prophecy formula\(^1\) (followed Mehrens and Lehmann, 1973, p.114).

\[ r_{xx} = \frac{k r_{ab}}{1 + r_{ab}} \]

where \( r_{xx} = \text{Reliability coefficient}, k = \text{number of judges (2)}, r_{ab} = \text{correlation between scores from judge A and B (0.93)}. \]
6.4.3 THE POST-EXERCISE UNIT STAGE TEST

This test was in fact 'a fixed jaw', one of the components of the small vice. It contained many tasks like those in the workshop exercises in the exercise unit stage, and even more in filing a round surface. Accuracies of this test component were the same as those of exercise 3 in the exercise unit stage.

Prior to undertaking his work, every student was tested in planning a sequence of operations from interpreting from the drawing. He also had to grade his finished work as well. Examples of the drawing and the grading sheet are given in Appendices C8 and C14.

The observation sheet proposed for use in this test contained a series of checklists similar to the one used in the first test. Observation was carried out in the morning and in the afternoon. An example of the observation sheet is given in Appendix C13.

Measurement of the students' tasks was accomplished in the same way as in the second test. The reliability coefficient of two judges (myself and a teacher) was 0.98 as computed with the Spearman-Brown prophecy formula (correlation = 0.97).

6.5 OTHER FACTORS

During the post-study unit and post-exercise unit stage, CC and ACC students were treated in the same way neither teachers nor peers were allowed to interfere with any student. Variables which could not be controlled were differences in the quality and condition of the tools, equipment and measuring instruments\(^1\), used by individual students, and sizes of stocks.

Two other major factors which might have large impact on student achievement were, the advice and guidance given by the teachers during normal training, and the progress of students themselves. Prior to the pre-study unit stage test, CC and ACC students had done the same practical exercises in each of the various topics in the study unit stage. But, for the exercise unit stage test their progress on

---

1. Squares and surface texture gauges were self-made.
workshop exercises were different. Four students (20%) from the ACC class has just finished 'a base' (let say exercise No. 4), 10 others (50%) were producing it, and the rest were about the finish exercise No. 3. Whereas 13 (72%) students of CC class had just finished exercise No. 3., and the rest were almost finishing it.

6.6 ANALYSIS OF FINISHED WORK

The grading of workshop tests mentioned previously involved both process and product, i.e., the performance of students during operations and the finished work. Data obtained during observations of student operations were analysed in terms of the number of mistakes each student made. To be analysed, finished work can be classified in terms of either quality specifications or production specifications, as shown in Diagram 6.1.

![Diagramme 6.1](image)

**Quality specifications**

- e.g. a = Dimension (length)
- b = Surface finish
- c = Squareness
- d = Surface level

**Product specifications**

- e.g. 1 = Tenon
- 2 = Block
- 3 = Radius
- 4 = Shoulder

Diagramme 6.1 An example of work measurement classifications of a piece of finished work in terms of either quality specification or production specifications.
The quality specifications were used only in the post-exercise unit stage test. A brief definition of classifications is given below.

Quality specifications are measurements of the same kind of quality using the same kind of instruments and method, and results are clustered into specific categories, e.g., surface finish, surface level, squareness and dimension. Production specifications, on the other hand, are composed of a variety of quality measurements, and results are clustered in terms of forming operations, e.g., block, shoulder, tenon, and radius. Table 6.2 indicates the item numbers of the quality measurements given on the grading sheet (see Appendix C14), being clustered into particular categories in accordance with either quality specifications or production specifications.

<table>
<thead>
<tr>
<th>Quality specifications</th>
<th>Production specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category</strong></td>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>Surface finish</td>
<td>2,5,8,11,14,17, 20,24,28,31,35, 39,42</td>
</tr>
<tr>
<td>Surface level</td>
<td>1,3,6,9,12,16, 19,23,27,30,34, 38,43</td>
</tr>
<tr>
<td>Squareness</td>
<td>4,7,10,13,21, 25,29,32,36, 40</td>
</tr>
<tr>
<td>Dimension</td>
<td>15,18,22,26, 33,37,41,44</td>
</tr>
</tbody>
</table>

Table 6.2 Quality measurements on the grading sheet clustered into particular categories in accordance with either quality specifications analysis approach or production specification analysis approach.
6.7 ANALYSIS

The main objectives of this section are to determine the development of student skills within the training stages and tests. Thus, any remarkable variations of students performances during normal training and testing could probably be noticeable. The emphasis of the analysis, however, will be on students' finished products.

To facilitate the evaluation the following questions were established as a guideline.

1. Was there any connection between skills in brickwork and joint finishing and those in benchwork?
2. What was the level of initial skills in students, in scribing, sawing, filing, scraping, chiselling, dieing, and drilling?
3. Were students ready for the training?
4. What mistakes did students usually make during operations.
5. What was the level of skills of students in production work during normal training and tests.
6. What were the areas of weakness of students in production work?
7. Could students cope with the present arrangement of the training and testing?
8. How many students could complete work successfully at the level of 80% on the overall quality specifications?

The 80% level of the overall quality specifications is in fact the criterion for passing. It is arbitrarily set up in this case so as to present data on the pass rate of students at various stages of the training and tests rather than as the concrete basis for determining the effectiveness of the training.

There has in the past been no standard or previous record of this kind for as long as this course has been run.

There will be no statistically significant test used in this section, as contents and difficulty level of each exercise and test were different. The analysis used for determining levels of skills
was based on the average achievement of students by which:

\( X = \) Good or acceptable.
\( I = \) Fair or within twice the limit of the specified tolerance,
\( O = \) Poor or unacceptable being beyond twice the limits of the specified tolerance.

For a satisfactory level of training and tests, the analysis used the average numbers of qualified specifications as measured on each item of finished work. It was determined by the formula:

\[
P_X = \frac{(N_X) 100}{k N}
\]

where \( P_X = \) Percentage of numbers of average acceptable measurements.
\( N_X = \) Number of acceptable measurements.
\( k = \) Number of items of quality measurement.
\( N = \) Number of students.

To facilitate interpretation of results a 5 percentage intervals was arbitrarily established as follows:

1. 0 - 100% = Very low.
2. 10 - 30% = Low
3. 30 - 70% = Moderate
4. 70 - 90% = High
5. 90 - 100% = Very high.

6.8 RESULTS

The results on the development of skills in students are presented in three successive stages: initial stage, early stage, and later stage.

6.8.1 INITIAL STAGE

As the 19 (one student was absent) ACC students were tested (in the pre-study unit stage test) only seven days after their first
semester final examination, their skills in Brickwork and Joint Finishing would have not been forgotten. This is because most motor skills are usually retained better and longer than anything else (Singer, 1975, Fleishman and Posner, 1962). Based on this notion, students should have scored very high on the test, if there was any connection between the skills in Brickwork and Joint Finishing and those in Benchwork, for the skills needed in the test were very basic and simple which could be successfully and quickly performed by a skilled person. The test results given in Table 6.3, indicate the average correct performances of students on seven skilled tasks with the levels of skills judged in accordance with the five percentage intervals mentioned previously. Their skills on those tasks were of a moderate level and one in scraping was very low. These consistent results of low level of achievements imply that there was no connection between skills in brickwork and joint finishing and those in benchwork.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>k</th>
<th>$\bar{X}$</th>
<th>S.D</th>
<th>$X_a$ (%)</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Scribing</td>
<td>6</td>
<td>2.8</td>
<td>0.50</td>
<td>46.7</td>
<td>M</td>
</tr>
<tr>
<td>2. Sawing</td>
<td>11</td>
<td>6.8</td>
<td>1.98</td>
<td>61.8</td>
<td>M</td>
</tr>
<tr>
<td>3. Filing</td>
<td>11</td>
<td>4.5</td>
<td>1.12</td>
<td>40.9</td>
<td>M</td>
</tr>
<tr>
<td>4. Chiselling</td>
<td>7</td>
<td>2.3</td>
<td>1.86</td>
<td>32.8</td>
<td>M</td>
</tr>
<tr>
<td>5. Scraping</td>
<td>5</td>
<td>0.5</td>
<td>0.61</td>
<td>10.0</td>
<td>VL</td>
</tr>
<tr>
<td>6. Dieing</td>
<td>7</td>
<td>2.8</td>
<td>2.22</td>
<td>40.0</td>
<td>M</td>
</tr>
<tr>
<td>7. Drilling</td>
<td>19</td>
<td>10.4</td>
<td>2.67</td>
<td>54.7</td>
<td>M</td>
</tr>
</tbody>
</table>

$k = \text{Number of quality measurements.}$

$X_a = \text{Average achievement.}$

$L = \text{Level of skills (M = medium, VL = very low).}$

Table 6.3 Test results of 19 students of the ACC class on 7 benchwork tasks, tested before the study unit stage.
The very low level of skill in 'scrapping' at this stage was not unusual. As the skill required in this case involved complex hand movements and controls of cutting forces and directions. The strong resistance on the work surface due to the negative rake angle of the scraper caused jerky cutting or loss of control on the movement of the scraper. Another reason perhaps was due to the way of holding the scraper. I would say, it was different from the way one usually does in everyday use. For example, the method used in this case required the left hand to hold the scraper down near to the cutting edge, whereas in everyday use one might hold it at the middle of the scraper.

A large number of students performed all other skills at the moderate level. This reflected their initial benchwork skills. It also implied that CC and ACC students were ready for skill practice in this course. However, special guidance might be needed for these students in the early stage of practice in scraping.

6.8.2 EARLY STAGE

In the first stage of the training students studied some workshop knowledge and carried out some practical exercises given in 11 topics within the study unit stage. The results, discussed in Chapters 4 and 5, indicate that students performed quite well as regards theory. For practical skills there were two distinct results. First, students could perform very well on scribing exercises, (see the results and the discussions in section 4.4.3(a)). Second, students could hardly perform exercises on filing, sawing and chiselling (see the results and the discussions in sections 4.4.3(b) and (c), respectively.

Reasons for these results could be summarized again as follows:

1. Simple tasks like scribing required a simple method of holding both work and tools, and simple movement of hands. Resistance to hand movement was low. In this circumstance, a description or a series of illustrations of the sequence of operations were sufficient for students to carry out their tasks successfully. External feedback from the teacher
might not be required if solutions to complete work were provided by, for example, illustrations of the complete work or as in this research by transparent templates of the complete work.

2. Difficult tasks like filing, sawing and chiselling required particular techniques in holding both work and tools. They demanded a great deal of co-ordination of hands and body which had not been part of their previous experience. Resistance to cutting force or movement was high. External feedback as provided on the study unit programmed texts in the form of a pictorial sequence of operations and illustrations of the complete work, was not useful. The teacher's help and constant guidance were required in shaping student's skills and control of movements.

At the end of the study unit stage, the practical test was administered to the 18 CC students and 19 (one was ill) ACC students (see the post-study unit stage test, section 6.4.2.) The summary of results from the observation as recorded on teachers' notes is as follows:

1. 3 ACC students (15.8%) and 2 CC students (11.1%) had difficulties in moving and controlling a file, even with advice and guidance from the teachers.

2. 2 ACC students (10.5%) changed from holding the straight handle of a saw to holding its frame, thus using an incorrect operating technique.

3. Many students of both classes put their tools and measurement instruments in a disorderly way in their bench. They argued, that others returning their tools did the same.

4. 12 ACC students (63.2%) and 4 CC students (22.2%) rubbed their hands on the surface of the piece being worked. Also 3 ACC students repeated this incorrect practice 3 times.
5. 3 ACC students (16.7%) measured their work in the vice only once.

As regards finished work, it was found that on average students of both classes performed well above the 'I' level (fair) but none reached the 'X' level (good) on all 5 quality specifications, as shown in Table 6.4. The average numbers of qualified measurements (X grade) for the 5 quality specifications of both classes are given in the 'Nx' column in Table 6.5. Transformation of the average numbers of acceptable measurement into levels on the 5 percentage intervals, under 'level' column, indicates the areas of weaknesses and satisfactory levels of student performance.

These results indicate that the performance of CC students were below satisfactory level (below H level) for items 2 to 5; and that for ACC students there were unsatisfactory performances on items 4 and 5.

The results on scribing here conflicted with the previous results during normal practice with the programmed text. This is most probably due to:

1. Lack of awareness in checking tool settings prior to commencing the operation.

2. Lack of practice in punching marks on scribed lines during the study unit stage.

3. The consequent effect of poor reference base surfaces on the workpiece itself.
<table>
<thead>
<tr>
<th>Quality</th>
<th>Weight score</th>
<th>Possible raw score</th>
<th>CC (N = 18)</th>
<th>ACC (N = 19)</th>
<th>Level of skills</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>S.D</td>
<td>X_w</td>
<td>X</td>
<td>S.D</td>
</tr>
<tr>
<td>Surface finish</td>
<td>12</td>
<td>36</td>
<td>34.9</td>
<td>2.68</td>
<td>11.6</td>
</tr>
<tr>
<td>Surface level</td>
<td>12</td>
<td>36</td>
<td>30.7</td>
<td>5.70</td>
<td>10.2</td>
</tr>
<tr>
<td>Squareness</td>
<td>12</td>
<td>24</td>
<td>18.2</td>
<td>3.99</td>
<td>9.1</td>
</tr>
<tr>
<td>Scribing</td>
<td>3</td>
<td>6</td>
<td>5.1</td>
<td>0.95</td>
<td>2.6</td>
</tr>
<tr>
<td>Sawing</td>
<td>3</td>
<td>12</td>
<td>9.6</td>
<td>1.43</td>
<td>2.4</td>
</tr>
</tbody>
</table>

\[ X_w = \text{Obtained weighted score} \]

<table>
<thead>
<tr>
<th>Quality</th>
<th>CC (N = 18)</th>
<th>ACC (N = 19)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N_x</td>
<td>%</td>
</tr>
<tr>
<td>1. Surface finish</td>
<td>16.33</td>
<td>90.72</td>
</tr>
<tr>
<td>2. Surface level</td>
<td>11.67</td>
<td>64.83</td>
</tr>
<tr>
<td>3. Squareness</td>
<td>6.50</td>
<td>36.11</td>
</tr>
<tr>
<td>4. Scribing</td>
<td>12.50</td>
<td>69.44</td>
</tr>
<tr>
<td>5. Sawing</td>
<td>9.00</td>
<td>50.00</td>
</tr>
<tr>
<td>Total</td>
<td>11.29</td>
<td>62.72</td>
</tr>
</tbody>
</table>

Table 6.4 Test results of CC and ACC students on 5 quality specifications and the average level of skills, on the post-study unit test.

Table 6.5 Average numbers of acceptable measurements and levels of performance on 5 quality specifications of CC and ACC students, on the post-study unit stage test.
6.8.3 LATER STAGE

Students came to the actual practice of production work first in the practice unit stage and next in the exercise unit stage where components of the small vice were produced. Grading finished work during normal training was done separately by the teachers of each class, but the average score from the teacher and myself was used for the post-exercise unit stage test. Details of conditions during training and test were discussed already (see section 6.4.3).

Descriptive results of students' work during normal training and test are given in Table 6.6. It indicates both the average achievement or level of skills in terms of the obtained weighted score (maximum 12) and the average numbers of acceptable measurements in terms of the absolute percentage on 5 quality specifications. In diagram 6.2 these results are also displayed in relation to the increment of working accuracies demanded on each work.

<table>
<thead>
<tr>
<th>Quality</th>
<th>work</th>
<th>$X_a$ (%)</th>
<th>$N_x$ (%)</th>
<th>Quality</th>
<th>work</th>
<th>$X_a$ (%)</th>
<th>$N_x$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CC  ACC</td>
<td>CC  ACC</td>
<td></td>
<td></td>
<td>CC  ACC</td>
<td>CC  ACC</td>
</tr>
<tr>
<td>Surface finish</td>
<td>PU 1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>PU 1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>PU 2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>PU 2</td>
<td>11.4</td>
<td>11.6</td>
</tr>
<tr>
<td></td>
<td>PU 3</td>
<td>11.8</td>
<td>11.3</td>
<td>93.4</td>
<td>85.8</td>
<td>85.6</td>
<td>91.4</td>
</tr>
<tr>
<td></td>
<td>EX 1</td>
<td>12.0</td>
<td>12.0</td>
<td>100.0</td>
<td>100.0</td>
<td>89.3</td>
<td>94.1</td>
</tr>
<tr>
<td></td>
<td>EX 2</td>
<td>11.8</td>
<td>11.9</td>
<td>98.6</td>
<td>96.9</td>
<td>85.8</td>
<td>91.4</td>
</tr>
<tr>
<td></td>
<td>EX 3</td>
<td>-</td>
<td>11.9</td>
<td>-</td>
<td>98.2</td>
<td>90.6</td>
<td>84.2</td>
</tr>
<tr>
<td></td>
<td>WS 3</td>
<td>10.6</td>
<td>11.4</td>
<td>63.8</td>
<td>86.3</td>
<td>11.3</td>
<td>96.3</td>
</tr>
<tr>
<td>Surface level</td>
<td>PU 1</td>
<td>11.9</td>
<td>12.0</td>
<td>96.3</td>
<td>100.0</td>
<td>90.6</td>
<td>86.7</td>
</tr>
<tr>
<td></td>
<td>PU 2</td>
<td>11.9</td>
<td>11.9</td>
<td>97.9</td>
<td>99.2</td>
<td>93.3</td>
<td>58.3</td>
</tr>
<tr>
<td></td>
<td>PU 3</td>
<td>11.8</td>
<td>11.8</td>
<td>94.8</td>
<td>95.6</td>
<td>9.1</td>
<td>9.6</td>
</tr>
<tr>
<td></td>
<td>EX 1</td>
<td>12.0</td>
<td>11.9</td>
<td>100.0</td>
<td>97.1</td>
<td>11.5</td>
<td>11.2</td>
</tr>
<tr>
<td></td>
<td>EX 2</td>
<td>11.8</td>
<td>11.5</td>
<td>97.6</td>
<td>88.5</td>
<td>11.5</td>
<td>11.1</td>
</tr>
<tr>
<td></td>
<td>EX 3</td>
<td>-</td>
<td>11.8</td>
<td>-</td>
<td>95.7</td>
<td>-</td>
<td>91.4</td>
</tr>
<tr>
<td></td>
<td>WS 3</td>
<td>9.8</td>
<td>11.0</td>
<td>45.7</td>
<td>70.6</td>
<td>8.9</td>
<td>9.8</td>
</tr>
</tbody>
</table>

= Practice unit, EX = Exercise unit, WS 3 = Post-exercise unit stage test,
= Average achievement, $N_x$ = Average number of acceptable measurement.

Table 6.6 Results on average achievement and average numbers of acceptable measurements on 5 quality specifications of both CC and ACC students during normal training and post-exercise unit stage test.
Diagram 6.2 Variations in accuracies, level of skill and average numbers of acceptable measurements of CC and ACC students in normal training and the post-exercise unit test.
From the diagram above, it can be seen that as the accuracies of practice unit works increase a slight drop in the average achievement (Xa) of both classes occurred in surface level and squareness, and a detrimental drop in dimension. The average achievement in dimension was the most critical and in surface level the least one. For exercise unit work, where levels of accuracies were constant, student achievement on all quality specifications fluctuated slightly in harmony, ie., a drop in surface finish on 'EX2' corresponding to a drop in surface level, squareness and dimension. These drops occurred again on the post-exercise unit stage test. For most of the work there was a sign of different levels of student achievement across all 4 quality specifications in the following order of increasing merit: surface finish, surface level, squareness and dimension.

In nearly all cases fluctuations in average achievement corresponded to that of average numbers of qualified acceptable measurements, (Nx). There were two practical unit works (PU2, PU3) where the numbers of acceptable measurements on dimension of both classes were below the satisfactory level (70%), and again on the post-exercise unit stage test. CC students had all 4 quality specifications below the satisfactory level on the test (WS3) whereas ACC students had two, ie., squareness and dimension.

The remarkable drops in students performances on the test (WS3) is most likely to be due to two major factors:

1. Slow working (especially CC) students, were anxious about the rate of their progress as compared with others. This is because all CC students did not attend the workshop on Thursdays whereas all ACC students did (notice that CC students had 3 days practice per week and ACC students 4 days per week).

2. In the test students experienced for the first time two new tasks, ie., forming a tenon and a radius. This might cause a number of errors in these parts of the work, due to the lack of experience. Further analysis on production specifications gives some support to this, as shown in Table 6.7. It indicates that both CC and ACC students had performed below the satisfactory level for
the radius. Also the CC students performed below the satisfactory level for the tenon.

<table>
<thead>
<tr>
<th>Production</th>
<th>CC (N = 18)</th>
<th>ACC (N = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>1. Square block</td>
<td>11.8</td>
<td>65.8</td>
</tr>
<tr>
<td>2. Shoulder</td>
<td>11.4</td>
<td>63.2</td>
</tr>
<tr>
<td>3. Tenon</td>
<td>8.0</td>
<td>44.6</td>
</tr>
<tr>
<td>4. Radius</td>
<td>6.7</td>
<td>37.1</td>
</tr>
<tr>
<td>Total</td>
<td>10.1</td>
<td>56.1</td>
</tr>
</tbody>
</table>

Table 6.7 Average numbers of acceptable measurements of CC and ACC students on 4 production specifications on the post-exercise unit stage test.

In addition to analysis of finished work, the following observational results indicate the students lack of good working habits.

1. Two CC students failed twice to keep his measuring instrument on the cloth provided.
2. Four ACC students and two CC students did not keep their tools in order.
3. One ACC student and one CC student did not keep the work bench and floor clean.
4. One CC student used their file incorrectly.
5. Three ACC students rubbed the work surface with their hand.
6. One ACC student used an incorrect sawing stroke.

Considering these results together with the previous observational results on the post-study unit test, there was no sign of poor working habits in any particular student. Moreover, similar examples of poor
working practice were still found on the post-exercise unit stage test, such as rubbing the work surface with a hand and placing tools and measuring instruments in a disorderly way.

Another important criterion to be considered in determining the level of development of student skills or in turn the effectiveness of the training programme is the pass rate. There were no data on this issue available from the previous training system, and no samples could be used especially at the middle of the semester. The arbitrary pass criterion was, then, set at 80%. Based on this criterion, it was found that on three occasions (out of eight), i.e., WS2, PU2 and WS3, the percentage of students who passed was less than 80%, as shown in Table 6.8. Thus, I would be certain that students of both classes so far could cope quite well with the present training programme.

<table>
<thead>
<tr>
<th>Work</th>
<th>Class</th>
<th>N</th>
<th>Percentage of student passing at various criterion scales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>60% 70% 80% 90% 100%</td>
</tr>
<tr>
<td>WS 2</td>
<td>CC</td>
<td>18</td>
<td>61.1 44.4 11.1 11.1 0</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>73.7 63.2 31.6 10.5 0</td>
</tr>
<tr>
<td>PU 1</td>
<td>CC</td>
<td>18</td>
<td>100.0 100.1 100.0 61.1 61.1</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>20</td>
<td>95.0 90.0 90.0 75.0 75.0</td>
</tr>
<tr>
<td>PU 2</td>
<td>CC</td>
<td>16</td>
<td>100.0 87.5 81.3 31.3 0</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>20</td>
<td>100.0 100.0 90.0 40.0 25.0</td>
</tr>
<tr>
<td>PU 3</td>
<td>CC</td>
<td>16</td>
<td>93.8 87.5 68.8 31.3 6.3</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>89.5 78.9 68.4 31.6 5.3</td>
</tr>
<tr>
<td>EX 1</td>
<td>CC</td>
<td>13</td>
<td>100.0 100.0 100.0 100.0 92.3</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>17</td>
<td>100.0 100.0 100.0 94.1 47.1</td>
</tr>
<tr>
<td>EX 2</td>
<td>CC</td>
<td>14</td>
<td>100.0 100.0 85.7 78.6 57.1</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>16</td>
<td>93.8 87.5 81.3 68.8 31.3</td>
</tr>
<tr>
<td>EX 3</td>
<td>CC*</td>
<td>-</td>
<td>-   -   -   -</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>14</td>
<td>100.0 100.0 100.0 71.4 42.9</td>
</tr>
<tr>
<td>WS 3</td>
<td>CC</td>
<td>18</td>
<td>44.4 33.3 5.6 0 0</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>18</td>
<td>88.9 72.2 55.6 16.7 0</td>
</tr>
</tbody>
</table>

N = Number of students who submitted the grading sheets.
* = Data not available due to diversion of plan as requested by the workshop teacher.

Table 6.8 Percentage of passing of both CC and ACC students on 8 works at different criterion scales.
6.9 CONCLUSIONS

Taking the results on the development of skills of students as discussed above, I make the following conclusions:

1. There was no connection between skills in brickwork and joint finishing and those in benchwork. This was due to differences in the nature of the two trades (construction and machine-shop mechanics).

2. Initial benchwork skills of both CC and ACC students were at moderate level. If new students to this course in the first semester have skills of similar level, my training approach should be as effective as these research results.

3. During the organizing phase (Fitts and Posner, 1967), i.e., the study unit stage and the practice unit stage, help and advice from the teacher were crucially important. Poor working habits such as leaving tools in a disorderly way, rubbing the work surface with the hand, and incorrect working methods should be corrected as soon as possible. Constant and immediate feedback from the teacher are needed. The information and 'cues for feedback' provided in my programmed texts were shown to be insufficient for students on difficult tasks such as filing. This is because students were still lacking tactile and kinesthetic senses, as was apparent in some students during their first trials.

4. Students should be informed and encouraged to take great care in producing work to acceptable dimensions (length, width, height).

5. Students should not be forced to work under time pressure or strict control, as this tended to spoil their work. This was the implication from analysis of students' work under test conditions where the working atmosphere was tense. (If the remarkable drop after a constantly high level of achievement on many tasks during the exercise unit stage). The effect of time on students' work was
also found in a correlation study as will be discussed later at the end of this chapter.

6. If new task were given to students for the first time, despite their having shown constant achievement, hints such as to common mistakes, techniques in operation, etc., had to be given prior to students working.

SECTION 2: DIFFERENCES BETWEEN CC AND ACC STUDENTS ON WORKSHOP ACTIVITIES

6.10 PRECONDITIONS

Both CC and ACC students had undergone the same training stages (SU, PU, and EX) and tests. The provision of information and aids and the demands on student activities were the same for both classes. For example, a pictorial sequence of operations was given in the practice unit stage but not in the exercise unit stage, and planning of operation sheets were demanded in the exercise unit stage. Even though, the two classes received different treatments and different working atmospheres depending on the teacher who handled and managed the system, as was evident from the numbers of returned grading sheets. I realized that CC students were not encouraged to plan their operation sheets; they simply followed the information given in the grading sheet which gave hints as to the sequence of operations to some extent.

There was no statistically significant difference between CC and ACC students as regards their physical characteristics, such as weight and height, but their age of ACC students on average was significantly higher statistically than that of CC students, at 95% confidence level, as shown in the results in Table 6.9.

<table>
<thead>
<tr>
<th>Physical characteristic</th>
<th>CC (N = 18)</th>
<th></th>
<th>ACC (N = 20)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>S.D</td>
<td>X</td>
<td>S.D</td>
</tr>
<tr>
<td>Age (Year)*</td>
<td>16.5</td>
<td>0.51</td>
<td>17.2</td>
<td>1.27</td>
</tr>
<tr>
<td>Weight (Kg.)</td>
<td>57.3</td>
<td>6.86</td>
<td>56.9</td>
<td>7.92</td>
</tr>
<tr>
<td>Height (cm.)</td>
<td>168.3</td>
<td>4.90</td>
<td>167.1</td>
<td>5.15</td>
</tr>
</tbody>
</table>

Table 6.9 Physical characteristics of CC and ACC students (year 1980)

* ACC students on average were older than CC students at $\alpha = 0.05$
6.11 ANALYSIS

The areas of difference between CC and ACC students in work­shop activities on the exercise and tests of the post-study unit and post-exercise unit stages can be classified as follows:

1. Product outcomes (finished work).
2. Production times.
3. Grading of finished work.
4. Planning operation sheets.

The statistical significance test used on finished work was the Mann-Whitney, as the scores on the finished work were on an ordinal scale (X,I,O). And t-test was used on production time, grading and planning, as scores were on an interval scale.

6.12 RESULTS

6.12.1 PRODUCT OUTCOMES

As each student's finished work on the post-study unit stage test was analysed in terms of quality specifications, it was found that there were statistically significant differences between CC and ACC students in surface level and squareness, as shown in Table 6.10.

Both quality specifications contributed greatly to a statistically significant difference in the total scores of the two classes.
Table 6.10 Differences between 18 CC students and 19 ACC students in average achievement for production work on the post-study unit stage test.

There are two main factors which probably account for the significant differences:

1. A difference due to the number of training hours per week, (ACC = 4 days/week, CC = 3 Days/week), in which allowed ACC students more time for practicing skills during the study unit stage.

2. An initial difference which existed between the two classes, as shown by some students who could hardly use a file on their work and needed teacher help. In this respect age is probably important as discussed later.

Differences due to the quality of measuring instruments and cutting tools used and to the sizes of stocks in this case, were
assumed to be equally distributed across these students.

On the post-exercise unit stage test, there were statistically significant differences between CC and ACC students as regards surface finish, surface level, and dimension. These three quality specifications consequently contributed to a statistically significant difference in the total scores of the two classes, as shown in Table 6.11.

<table>
<thead>
<tr>
<th>Quality</th>
<th>Class</th>
<th>( \bar{X} )</th>
<th>S.D</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Surface</td>
<td>CC</td>
<td>138.2</td>
<td>12.4</td>
<td>254.5**</td>
</tr>
<tr>
<td>finish</td>
<td>ACC</td>
<td>147.9</td>
<td>9.0</td>
<td></td>
</tr>
<tr>
<td>2. Surface</td>
<td>CC</td>
<td>127.4</td>
<td>12.1</td>
<td>217.5**</td>
</tr>
<tr>
<td>level</td>
<td>ACC</td>
<td>143.4</td>
<td>11.0</td>
<td></td>
</tr>
<tr>
<td>3. Squareness</td>
<td>CC</td>
<td>104.7</td>
<td>9.1</td>
<td>278.0*</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>108.9</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>4. Dimension</td>
<td>CC</td>
<td>71.0</td>
<td>10.9</td>
<td>270.5*</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>78.6</td>
<td>9.9</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>CC</td>
<td>441.3</td>
<td>29.9</td>
<td>437.0**</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>478.8</td>
<td>29.9</td>
<td></td>
</tr>
</tbody>
</table>

\( W = \) Mann - Whitney statistic

* \( P < 0.05 \)

** \( P < 0.01 \)

Note: Each pair of data is calculated independently.

Table 6.11 Differences between 18 CC and 18 ACC students as regards four quality specifications and the total score, on the post-exercise unit stage test.

One major factor accounting for the differences above was the progress rate resulting from the difference in the number of training hours per week. As the evidence shown in Table 6.12 indicated that four ACC students who had just finished exercise 4 (EX4+) had scores significantly higher statistically than combination students (4 ACC
and 5CC) who had just finished exercise 3 (EX3+) and than 13 students who were pursuing exercise 3.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>$\bar{X}$</th>
<th>S.D</th>
<th>EX4⁺</th>
<th>EX4</th>
<th>EX3⁺</th>
</tr>
</thead>
<tbody>
<tr>
<td>EX4⁺</td>
<td>4</td>
<td>495.0</td>
<td>10.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>EX4</td>
<td>10</td>
<td>471.8</td>
<td>37.1</td>
<td>36.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>EX3⁺</td>
<td>9</td>
<td>454.0</td>
<td>31.5</td>
<td>42.0*</td>
<td>115.0</td>
<td>-</td>
</tr>
<tr>
<td>EX3</td>
<td>13</td>
<td>444.5</td>
<td>32.4</td>
<td>59.5**</td>
<td>149.5</td>
<td>114.0</td>
</tr>
</tbody>
</table>

* P < 0.05  ** P < 0.01

Table 6.12 Differences in average achievement on the post-exercise unit stage test as classified in accordance with different training progress.

There are three possible reasons for the significant differences above:

1. These four students were extraordinarily good students, as could be seen from their rate of progress. Theoretically, there is a case that a skilled performer needs less information, hints and checking and makes fewer mistakes. These factors contributed to fast working as well as good results.

2. It was not only skills that improved along with training, knowledge and skill both improve with it, as each exercise in this course had different sizes and shapes required different control and attention to each particular point. For example, filing a flat surface on a thin short work-piece requires a great deal of control on cutting forces and level of file movement, otherwise an undersize, tilted surface or damage to the end surfaces may occur. The ability to anticipate faults and skill in correcting mistakes minimized the number of mistakes on the new work. Based
on this conceptualization, the greater the amount of practice the higher the chance to minimizing mistakes.

3. Skills which improved over many exercises contributed to an ability to control cutting forces, the movement of cutting tools and an accurate vision and discrimination of gaps or spaces between measuring instruments and work surfaces. These skills were crucially important for this kind of production work.

Evidence for the reasons given above, can be found from the average scores of the four groups of students (see Table 6.12), which was corresponding to the position of student rate of progress. This implied that the greater the experience on working the higher the achievement. This statement was true, according to the above evidence, as far as conditions in training between CC and ACC students and their rate of progress were concerned.

Age may be another factor accounting for differences between CC and ACC students on production work. As both classes were combined and then divided into 3 age groups when their achievements in both the post-study unit stage and the post-exercise unit stage tests were compared.

It was found that students more than 18 years old performed better than 16 and 17 year old students on both tests, as shown in Table 6.13. Notice that the results on both tests were identical in pattern indicating the worst performances by 17 year old students. A statistically significant difference on score distribution was found, at $\alpha = 0.05^1$, between 18+ and 17 year old students on the post exercise unit stage test (WS3). This indicated that age partly accounted for the statistically significant differences between CC and ACC students on production work on both the tests mentioned above.

1. The Mann–Whitney statistic was used, based on the assumption that student scores were on an ordinal scale.
<table>
<thead>
<tr>
<th>Test</th>
<th>Age (year)</th>
<th>N</th>
<th>Achievement</th>
<th>Mann - Whitney</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>S.D</td>
</tr>
<tr>
<td>WS 2</td>
<td>16</td>
<td>17</td>
<td>102.6</td>
<td>9.6</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>15</td>
<td>101.03</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>18+</td>
<td>5</td>
<td>104.2</td>
<td>6.6</td>
</tr>
<tr>
<td>WS 3</td>
<td>16</td>
<td>17</td>
<td>461.1</td>
<td>36.9</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>14</td>
<td>448.7</td>
<td>33.0</td>
</tr>
<tr>
<td></td>
<td>18+</td>
<td>5</td>
<td>488.4</td>
<td>17.3</td>
</tr>
</tbody>
</table>

* P < 0.05  
N = Number of students

Table 6.13 Differences in workshop performance of CC and ACC students classified into 3 age groups, in post-study unit stage (WS 2) and post-exercise unit stage test (WS 3).

There are two aspects from the results above. First, the lack of a statistically significant difference between 18+ and 16 year old students. This was probably due to the numbers of students involved being too small, particularly as regards students over 18. Second, performances of 17 year old students were poorer than those of 16 year old students. This was rather strange. But similar curvilinear relationships were also discovered between reaction time and age. Hodgkins (1963) discovered that reactions improve from childhood to nineteen years and decreased afterward, but a slight drop was observed at the age of about fifteen 1.

1. Singer (1975), Motor Learning and Human Performance, p.329.
6.12.2 PRODUCTION TIMES

Although, there were statistically significant difference between CC and ACC students as regards product outcomes in both the post-study unit stage and the post-exercise unit stage tests, there were no statistically significant differences between the two classes in production times in the two tests. Their mean differences were less than 1 S.D., as the results in Table 6.14 show, where ACC slow working extremists have been excluded (one on the post-study unit stage and three on the post-exercise unit stage tests). These findings were still unchanged even in case of the ACC slow working extremists are included.

<table>
<thead>
<tr>
<th>Post-study unit stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
</tr>
<tr>
<td>CC</td>
</tr>
<tr>
<td>ACC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-exercise unit stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
</tr>
<tr>
<td>CC</td>
</tr>
<tr>
<td>ACC</td>
</tr>
</tbody>
</table>

Table 6.14 Differences between CC and ACC students on production times on both the post-study unit stage and post-exercise unit stage tests.

On average, ACC students took 36 minutes longer in production time than CC students did on the post-study unit stage test. The quickest students of both classes finished work at almost the same time. (This was taken when they submitted their work together with their grading sheets, i.e., the time spent in grading finished work was included in production time.)
For the post-exercise unit stage test, ACC students on average took 1 hour less in production time than CC students did. The fastest ACC student finished his work 54 minutes before the fastest CC student.

The results above indicate no statistically significant differences between the two classes on production time. This could imply that the physical strength to withstand fatigue and to exert cutting forces were equally distributed between the classes.

6.12.3. GRADING FINISHED WORK

As part of the training CC and ACC students had to grade their finished work according to given rules and grading sheets. The results in Tables 15a and 15b show differences in average achievement scores on student grading and on teacher/researcher grading for both post-study unit stage and post-exercise unit stage tests. It indicated that students of both classed awarded themselves higher scores for their finished work, than the teacher and the researcher did. There were statistically significant differences between ACC students' grading and teacher's and researcher's grading on both post-study unit stage and post-exercise unit stage tests. Whereas a statistically significant difference was found for CC students' grading only on the post-exercise unit stage test.

<table>
<thead>
<tr>
<th>Class</th>
<th>Judge</th>
<th>( \bar{X} )</th>
<th>S.D</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC (N = 18)</td>
<td>A</td>
<td>97.7</td>
<td>10.90</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>99.1</td>
<td>9.65</td>
<td>257.5</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>100.3</td>
<td>10.60</td>
<td>239.0</td>
<td>250.0</td>
</tr>
<tr>
<td>ACC (N = 19)</td>
<td>A</td>
<td>105.5</td>
<td>6.32</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>105.5</td>
<td>6.39</td>
<td>334.5</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>110.8</td>
<td>3.68</td>
<td>243.0***</td>
<td>244.0***</td>
</tr>
</tbody>
</table>

A = The researcher
B = The workshop teacher
C = Students

Table 6.15(a) Differences in grading of finished work by the researcher, a workshop teacher and the students themselves in the post-study unit stage test.
### Differences in grading of finished work by the researcher, a workshop teacher and the students themselves in the post-exercise unit stage test.

<table>
<thead>
<tr>
<th>Class</th>
<th>Judge</th>
<th>( \bar{X} )</th>
<th>S.D.</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC</td>
<td>A</td>
<td>442.2</td>
<td>28.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>440.4</td>
<td>31.3</td>
<td>345.0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>470.9</td>
<td>23.2</td>
<td>243.5**</td>
<td>240.0**</td>
</tr>
<tr>
<td>ACC</td>
<td>A</td>
<td>476.4</td>
<td>31.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>481.1</td>
<td>28.3</td>
<td>322.0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>503.6</td>
<td>16.3</td>
<td>239.5**</td>
<td>251.5**</td>
</tr>
</tbody>
</table>

A = The researcher

B = The workshop teacher

C = Students

The absence of statistically significant differences between the teacher's and the researcher's grading of the students' finished work on both tests could be explained as follows:

1. Both the teacher and the researcher used good quality standard measuring instruments.
2. Both the teacher and the researcher had achieved the same high level of skill.
3. Gradings were accurate both for physical measurements and for quality judgements due to the common grading scale \((X, I, O)\) by which they were based on precise criteria. It is the objectively based measurement.
Statistically significant differences between student grading and teacher/researcher grading can probably be explained as due to student prejudice. Other factors which could account for this will be discussed later in this section.

The discussion thus far, has concerned only students awarding grades different from the teacher and the researcher. Now we consider the differences in gradings given by CC and ACC students.

The skill of students in grading finished work, was determined by the number of gradings in agreement with the average scores of both the teacher and the researcher. Differences between CC and ACC students in these numbers were then compared and tested with the pooled variance formula.

It was found that there were statistically significant differences, at 99% confidence level, between CC and ACC students on their gradings for surface level and squareness on the post-study unit stage test. But no statistically significant differences were found in any quality specifications for the two shown in diagrams 6.3(a) and 6.3(b).

\[\begin{array}{cccccc}
\text{a) Post-study unit stage} & & & & & \\
\text{ACC} & 81.5 & 94.4 & 86.0 & 55.5 & 48.6 \\
\text{CC} & 87.5 & 64.6 & 43.8 & 68.8 & 46.9 \\
\end{array}\]

\[\begin{array}{cccccc}
\text{b) Post-exercise unit stage} & & & & & \\
\text{ACC} & 93.8 & 90.0 & 87.0 & 83.8 & 83.1 & 88.0 & 82.5 \\
\text{CC} & 83.8 & 83.1 & 88.0 & 82.5 & \\
\end{array}\]

Diagram 6.3 Differences between CC and ACC students in correct grading of finished works, on the post-study unit stage and post-exercise unit stage tests.
There are four main factors probably accounting for statistically significant differences between teacher/researcher grading and student grading, and differences between CC and ACC students on number of correct grading. These factors are as follows:

1. Quality of finished work.
2. Accuracy of work.
3. Human error.
4. The grading scale used.

The first three factors influence the number of correct grading and the fourth influences the magnitude of score on each grading difference. As indicated in diagram 3a, ACC students generally had higher numbers of correct gradings than CC students had. But ACC students on average scored significantly higher statistically than teacher/researcher did, while CC students did not. This implied that ACC students awarded full grades for themselves, more often than did CC students, and at the same time CC students awarded lower grades for themselves more often than ACC students did. The impact of the grading scale was apparent on the post-exercise unit stage test where both classes had higher rate of correct grading than compared to the post-study unit stage test (see diagrams 6.3(a) and 6.3(b)). But these were statistically significant differences on average scores between both classes and the teacher/researcher.

The impact of the first three factors mentioned previously, on the numbers of correct grading could be explained as follows:

The quality of finished work may be considered in terms of average achievement (Xa). Referring to the results on Table 6.5, and Table 6.6, it was found that the number of correct grading (Nx) associated almost directly with the average achievement as shown in diagram 6.4. Generally it could be stated that the higher the average achievement the higher the number of correct gradings.
Diagram 6.4 Relationship between average achievements on production work and average numbers of correct gradings of CC and ACC students on both post-study unit stage and post-exercise unit stage tests.
That is, poor quality of work is likely to lead to error in measurement, because:

a. No single repeated measurement will be on exactly the same location.

b. A poor work surface (e.g., surface level) will potentially cause improper base for measurement.

c. Poor quality work may influence personal impression (human error).

The accuracy of work influences the number of correct gradings in the sense that one can hardly differentiate between 0.1mm and 0.2mm gaps but one could do it quite easily between 1.0mm and 2.0mm gaps. Based on this concept, then, there is a case for believing that ACC students awarded full grades for themselves more often than did CC students.

Human error in measurement could have some impact on the number of correct gradings, despite the range of grading scales was given in step of twice the stated tolerance. But there was no evidence to justify any error caused by this factor. Human error could arise from prejudice, emotion or measuring skills.

Apart from testing differences between student grading and teacher/researcher grading of finished work, there is one important educational implication worth discussing here. That is the influence of grading activity on the improvement of workshop skills. Based on a course construction point of view, it is quite certain that the difficulty level in grading finished work on the post-exercise unit stage test is much higher than that of the post-study unit stage test both in terms of the scope of the contents and the accuracy of work. The results shown in Diagram 6.3, clearly indicate the remarkable increase in the numbers of correct gradings of both classes on the post-exercise unit stage test. Also evidence shows that average achievement on production work is highly associated with the numbers of correct gradings. It is, therefore, quite reasonable to believe that both skills in production work and skills in measuring promote each other. It is in the sense that measurement of work done precedes the finished work and the quality of work being done demands
skills in measuring. Thus, it is reasonable to convince teachers concerned to devote themselves to encouraging and implementing this grading activity along with workshop training.

6.12.4 PLANNING OPERATION SHEETS

As described earlier there was no pictorial sequence of operations given in any exercises in the exercise-unit stage. For ACC students, I did encourage them to plan their own operation sheets either individually or co-operatively. And they discussed their plans with me individually, prior to starting production of their work. CC students on the other hand were not encouraged by their supervisors, but they could follow a sequence of grading given in the grading sheet as a guide.

Analysis of the results of the post-exercise unit stage test on planning operation sheets of a Fixed Jaw, as shown in Table 6.16., indicated that mean scores of ACC students were significantly higher statistically than those of CC students as regards sequence of operations, description, details of tools used and lastly total scores.

<table>
<thead>
<tr>
<th>Item</th>
<th>Class</th>
<th>( \bar{X} )</th>
<th>S.D</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Description</td>
<td>CC</td>
<td>2.1</td>
<td>0.6</td>
<td>-5.52 **</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>3.7</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>2. Sequence</td>
<td>CC</td>
<td>2.8</td>
<td>0.5</td>
<td>-3.19 **</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>3.7</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>3. Tools used</td>
<td>CC</td>
<td>1.8</td>
<td>0.6</td>
<td>-4.96 **</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>2.9</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>CC</td>
<td>6.6</td>
<td>1.26</td>
<td>-5.28 **</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>10.3</td>
<td>2.54</td>
<td></td>
</tr>
</tbody>
</table>

** P < 0.01

Table 6.16 Differences between 16 CC and 18 ACC students on planning the operation sheet of a Fixed jaw.

206
Theoretically, it was conceivable that those statistically significant differences were due to the treatment given to the ACC students. This is because the knowledge required for planning had not been provided elsewhere in the study unit stage, except where students might have learned it from pictorial sequence of operations given in the programmed texts in the practice unit stage and some from experiences gained during working. Knowledge of technical drawing and benchwork theory also contributed towards planning, as is discussed later in section 6.16.1.

6.13 CONCLUSIONS ON DIFFERENCES BETWEEN CC AND ACC STUDENTS ON WORKSHOP TRAINING

Based on the evidence and discussions of the research results the following four conclusions can be drawn:

1. The number of practice-in-workshop exercises has a strong impact on the achievement of students. There is evidence for the post-exercise unit stage test that the greater the practice the higher the level of achievement.

2. There is evidence showing that the levels of achievement on production work highly associated with the numbers of correct gradings. And there are reasons to believe that skills in production work and skills in measuring promote each other. Teachers concerned should, therefore, be convinced to implement the activity of grading finished work by students, along with workshop training in order to accelerate the student achievement in production work.

3. There is evidence showing that ACC students who have special treatment in planning their operation sheets during training performed significantly better statistically than CC students who have no special treatment (encouragement to planning). Research results have shown that simply conditioning students by removing pictorial sequence of operations and still retaining sequence in grading sheets, lead to students will follow the latter. This conditioning situation has proved ineffective in encouraging students
SECTION 3: FACTORS AFFECTING WORKSHOP SKILLS AND ACTIVITIES

6.14 A SYSTEM DIAGRAM

One way of viewing workshop skill training is as a system having a certain input and output (Traver, 1977, p.105). The system may contain in itself many elements forming a sub-system, or it can be part of a larger system that working forwards as an entire functioning unit to achieve some objectives. Within the system of my benchwork training, see diagram 6.5, it contains two input sub-systems (ie., instruction and training, and immediate environment), acting upon the next sub-system called in this case the post-exercise unit stage in which has as sub-systems, students and their output. An immediate objective of the output is the production of finished work.

Diagramme 6.5 A simplified system diagram of the benchwork training.
In the instruction and training system, are contained in fact various successive stages of training and tests, i.e., study unit stage, practice unit stage, consolidating unit stage, exercise unit stage, and their terminal tests. Factors involved in this system can be classified into two categories: workshop knowledge and workshop skills. At the final stage of training i.e., exercise unit stage, students can be thought of having knowledge of technical drawing, benchwork theory and the planning of operation sheets. The last of these is conceivably generated by the interaction of the first two and cognitive experiences gained from workshop exercises and the previous workshop test. This can be presented in terms of a model as shown in Diagram 6.6. All workshop knowledge is also thought of influencing to some extent the successful production of workpieces.

Diagram 6.6 A model of knowledge of planning generated by previous study and workshop practice and impact of workshop knowledge on workshop skills.
Workshop skills, on the other hand, are thought of as to be the accumulation of previous workshop practices, and a test at the end of the study unit stage as shown in Diagram 6.7. It is interesting in this case to see how stable is status of students across all practices or whether there is any particular trend of relationship among successive practices.

Diagram 6.7  A model workshop skill training.

6.14.2 IMMEDIATE ENVIRONMENT

In the testing situation students probably were working in competitive fashion against the proposed target time. It was different from normal training in the sense that they were allowed neither to work during breaks or lunch times nor to work co-operatively with friends. This proposed target time and test atmosphere, might have some influence on students' actual production time and consequently the quality of their finished work. It is doubtful whether there is any statistically significant relationship between achievement on production work and production time in test situations.

6.14.3 PHYSICAL CHARACTERISTICS

Singer (1975, p.252) states that in general height and weight factors are not valid predictors of athletic success; at least, in physical education classes. I shall adopt this statement and not take these factors into account in my study. Strength no doubt affects the ability to withstand fatigue and in turn may affect production time or possibly product outcome of students. But this factor and
6.15 ANALYSIS

The main objectives in this section are to determine the following:

1. The contribution of knowledge of technical drawing and benchwork theory on planning.

2. The relationship between the achievement in production work and technical drawing, benchwork theory, and planning.

3. The relationship between the achievement on product outcomes and production time.

4. The relationship between the achievements of production work in the successive training and tests.

The contribution of knowledge of technical drawing and benchwork theory to planning, see diagram 6.2., can be determined by using multiple correlation analysis. In general terms achievement in planning is expressed as due to:

1. Technical drawing  
2. Benchwork theory  
3. Technical drawing and benchwork theory  
4. Other factors not measurable in the situation  

Total 100

For analysis of the relationships of the various factors mentioned in item 2, 3 and 4 above, the Pearson product-movement correlation formula is used, based on the assumption that data are in interval scale including scores on students' finished work.

6.16 RESULTS

6.16.1 CONTRIBUTION OF WORKSHOP KNOWLEDGE TO PLANNING

There were 16 CC students (89%) and 18 ACC students (90%), taken into account in the determination of the contribution of workshop knowledge to planning; one ACC student was ill and others were reported as having lost their operation sheets during the test.

Intercorrelation coefficients for the 3 variables involved for both classes (see Table 6.17), were at the moderate level and showing a statistically significant relationship among them. Having loaded these values into the multiple correlation equation, it gave percentages of variables contributed to planning, as shown in Table 6.18.

(a) CC students

<table>
<thead>
<tr>
<th></th>
<th>BT</th>
<th>Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>BT</td>
<td>0.60*</td>
<td></td>
</tr>
<tr>
<td>Plan</td>
<td>0.47*</td>
<td>0.63**</td>
</tr>
</tbody>
</table>

N = 16  P < 0.1  * P < 0.05  ** P < 0.01

(b) ACC students

<table>
<thead>
<tr>
<th></th>
<th>BT</th>
<th>Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>BT</td>
<td>0.65**</td>
<td></td>
</tr>
<tr>
<td>Plan</td>
<td>0.52**</td>
<td>0.56**</td>
</tr>
</tbody>
</table>

N = 18  DG = Technical drawing  BT = Benchwork theory  Plan = Planning

Table 6.17 Intercorrelation coefficients for three variables for (a) 16 CC students and (b) 18 ACC students.
<table>
<thead>
<tr>
<th>Success on planning due to:</th>
<th>CC plan</th>
<th>ACC plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 16</td>
<td></td>
<td>N = 18</td>
</tr>
<tr>
<td>1. Technical drawing</td>
<td>2.03 %</td>
<td>7.62 %</td>
</tr>
<tr>
<td>2. Benchwork theory</td>
<td>29.72 %</td>
<td>14.16 %</td>
</tr>
<tr>
<td>3. Tech. and Bench.</td>
<td>9.25 %</td>
<td>13.52 %</td>
</tr>
<tr>
<td>4. Others</td>
<td>59.00 %</td>
<td>64.70 %</td>
</tr>
<tr>
<td>Total</td>
<td>100.00 %</td>
<td>100.00 %</td>
</tr>
</tbody>
</table>

Table 6.18 Results on contributions of workshop knowledge on planning for both CC and ACC classes.

The results shown in Table 6.18., indicate similar results for both classes. It was found that technical drawing contributed less than 8% to the achievement of planning, whereas benchwork theory contributed between 15 and 30%. The interaction between them was about 10 to 15%, and other factors 59 to 65%.

Taking the average achievement in planning of both classes, discussed previously, (see section 6.12.4) into consideration, it became apparent that the performance of ACC students was significantly higher statistically than that of CC students. It was also shown in this multiple correlation study that the contribution from 'other factors' for ACC students was higher than that of CC students. Theoretically, I believed, that the other factors would be chiefly the knowledge of planning exercises itself.

The explanation given below will emphasis two aspects: (1) why technical drawing was in moderate and statistically significant correlation to benchwork theory, and (2) why the contribution to planning from technical drawing was less than that of benchwork theory.

Having considered the contents in both technical drawing and
benchwork theory, it could be easily recognized that they were entirely different from each other. But both of them were needed for and integrated within the planning. This latter aspect certainly blended both technical drawing and benchwork theory to a moderately significant relationship. It was found later that the strengths of relationship between both subjects were reduced to 0.38 for ACC class and 0.44 for CC class, where planning was isolated. But still a statistically significant relationship remained for CC class. The strength of correlation of both classes at this level could be explained as due to inter-individual differences among students in each class which at moderate level, as far as cognitive ability was concerned.

The lesser contribution from technical drawing to planning compared with that from benchwork theory, could be explained as follows:

1. A student needs technical drawing in order to perceive what shape the work is likely to have at each stage and at the end of the production.

2. A student needs technical drawing simply for reference when planning and measuring work are needed, but

3. A student needs benchwork theory in order to establish strategies and methodologies to produce the work.

4. A student needs benchwork theory to anticipate faults, and the means to correct faults/mistakes.

5. A student needs benchwork theory to prescribe suitable tools and equipment in each step of production.

6. The state of complexity of the theory involved in bench-

1. A partial correlation was used by which:

\[ r_{12,3} = \frac{r_{12} - r_{13} r_{23}}{\sqrt{1 - r_{13}^2} \sqrt{1 - r_{23}^2}} \]

where

- \( r_{12} = \text{corr. DG and BT} \)
- \( r_{13} = \text{corr. DG and plan} \)
- \( r_{23} = \text{corr. BT and plan} \)
work is higher than that in technical drawing in which illus-
trations concretely exhibit the work.

The evidence discussed above should convince teachers concerned to emphasise their effort on planning exercises no less than on work-
shop skill practice. Also emphasis should be given to knowledge on both technical drawing and benchwork theory. Because these two areas of knowledge are shown to be in statistically significant relationship to each other and to planning.

6.16.2 RELATIONSHIP BETWEEN ACHIEVEMENT IN PRODUCTION WORK AND PLANNING, TECHNICAL DRAWING AND BENCHWORK THEORY

One technique used in determing the relationship between the terminal workshop skill and workshop knowledge is by correlation study. The results in Table 6.19, indicate strengths of relationships between the achievement on production work (WS3) and knowledge on planning, technical drawing, and benchwork theory, for 16 CC students and 18 ACC students on the post-exercise unit stage test. It was found that relationships between production work and planning for both classes were almost identical (CC = 0.41, ACC = 0.49) at a moderate level, whereas the relationships between production work and technical drawing were slightly different (CC = 0.3, ACC = 0.46), but quite different to the relationships between production work and benchwork theory. All the results for ACC class had shown statistically significant relationships, but none for CC class.

Inconsistent results between both classes on relationship between production work and benchwork theory might be due to chance alone because of unstability of students' status on successive practice as discussed later.

The lack of statistically significant relationship for the CC class might probably be due to loss in number of students.

It was also found that there was a similar trend for strengths of these relationships for both classes. This, therefore, confirmed that planning had more influence on production work than technical drawing and this in turn had a greater influence than theory. Notice that strengths of relationships for ACC class were very similar.
<table>
<thead>
<tr>
<th>Correlation between WS 3 and</th>
<th>CC (N = 16)</th>
<th>ACC (N = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Planning 0.41</td>
<td>0.49*</td>
<td></td>
</tr>
<tr>
<td>2. Technical drawing 0.30</td>
<td>0.46±</td>
<td></td>
</tr>
<tr>
<td>3. Benchwork theory 0.11</td>
<td>0.44±</td>
<td></td>
</tr>
</tbody>
</table>

WS 3 = production work on the post-exercise unit stage test.
* P < 0.05
+ P < 0.1

Table 6.19 Correlation coefficients between production work and three workshop knowledge for both CC and ACC classes on the post-exercise unit stage test.

The coefficients of determination of the above results indicated that the achievement on production work in the post-exercise stage for CC and ACC students respectively were 16.8% and 24% for planning, 9% and 21.2% for technical drawing, and 1% and 19.4% for benchwork theory. This implied that these areas of workshop knowledge have an effect, albeit small, on benchwork skills.

This could be explained as due to most benchwork skills like filing, sawing, chiselling, etc., demand a great deal of motor skills rather than cognitive ones. The concept of the relative amount of motor to cognitive skills would be apparent if a distinction would be made between skills in filing and drilling. The latter would certainly require more cognitive skills than the former, and vice versa for motor skills. This is because the work done in drilling is mostly accomplished by the machine rather than the hands.

6.16.3 RELATIONSHIP BETWEEN ACHIEVEMENT ON PRODUCTION WORK AND PRODUCTION TIME

As mentioned earlier that it is doubtful whether there is a statistically significant relationship between the achievement on production work and the production time under test situations. Results on correlation coefficient between the achievement on production work and the production time on both the post-study unit stage test and the post-exercise unit stage test were given in Table 6.20.
Table 6.20 Correlation coefficient between achievement on production work and production time for CC and ACC students, on post-study unit stage and post-exercise unit stage test.

The results on both tests indicated consistently similar negative correlation coefficients at low level for both CC and ACC classes. And there was no statistically significant relationship between the achievement on production work and production time. Even so, consistent results for both classes over two separate tests had some educationally significant implication. In this case it means that the shorter the production time the poorer the quality of work. This implication theoretically should apply for only the poorer students because better students who had mastered their skills would produce accurate qualified work consistently in a reasonable time. But since the values of correlation were low and lacking statistical significance, this would seem to imply as well that results on both tests may occur by chance. This in turn probably suggests that poorer students might rush on their work in the test situation. However, there is not enough evidence to support this interpretation.

6.16.4 RELATIONSHIP BETWEEN THE ACHIEVEMENT ON PRODUCTION WORK AND SUCCESSIVE TRAINING AND TESTS

The objective in this part is to determine relationships among successive practice and tests on achievements of students on production work. Due to some students not returning their grading sheets for some exercises, the number of students for intercorrelation across all exercises and tests were low, i.e., 8 (44.4%) for CC class, and 11 (55.0%) for ACC class. This will inevitably distort information and the study. Therefore, a number of separate correlations will be presented as follows:

<table>
<thead>
<tr>
<th>Test</th>
<th>Class</th>
<th>N</th>
<th>Correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS 2</td>
<td>CC</td>
<td>18</td>
<td>-0.30</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>19</td>
<td>-0.37</td>
</tr>
<tr>
<td>WS 3</td>
<td>CC</td>
<td>18</td>
<td>-0.38</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>18</td>
<td>-0.20</td>
</tr>
</tbody>
</table>

WS 2 = Post-study unit stage test.  
WS 3 = Post-exercise unit stage test.
1. Relationship of student achievement within the practice unit stage.
2. Relationship of student achievements within the exercise unit stage.
3. Relationship of student achievement between the post-study unit stage test and terminal exercises\(^1\) of both practice unit stage and exercise unit stage.
4. Relationship of student achievement between the post-exercise unit stage test and terminal exercises of practice unit stage and exercise unit stage and the post-study unit stage.

All correlations in this study were computed with the Spearman's rank order correlation formula based on the assumption that students' scores were on an ordinal scale (X, I, O). Results of all correlations mentioned above are given in Table 6.21 below.

---

1. Many possible student scores can be used e.g., average scores across all trials, gain scores, best scores or terminal scores (Kroll, 1967; Henty, 1967; Heatherington, 1973; McCraw, 1955). I used terminal scores at each training stage, based on the assumption that students will perform better each time.
### CC class

<table>
<thead>
<tr>
<th></th>
<th>PU1</th>
<th>PU2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PU2</td>
<td>-0.18</td>
<td>—</td>
</tr>
<tr>
<td>PU3</td>
<td>-0.11</td>
<td>0.08</td>
</tr>
</tbody>
</table>

### ACC class

<table>
<thead>
<tr>
<th></th>
<th>PU1</th>
<th>PU2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PU2</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>PU3</td>
<td>0.03</td>
<td>0.65**</td>
</tr>
</tbody>
</table>

a) Correlation coefficients for exercises in the practice unit stage.

### CC class

<table>
<thead>
<tr>
<th></th>
<th>EX1</th>
<th>—</th>
</tr>
</thead>
<tbody>
<tr>
<td>EX2</td>
<td>-0.22</td>
<td>—</td>
</tr>
</tbody>
</table>

### ACC class

<table>
<thead>
<tr>
<th></th>
<th>EX1</th>
<th>EX2</th>
</tr>
</thead>
<tbody>
<tr>
<td>EX2</td>
<td>0.16</td>
<td>—</td>
</tr>
<tr>
<td>EX3</td>
<td>0.31</td>
<td>0.58+</td>
</tr>
</tbody>
</table>

b) Correlation coefficients for exercises in the exercise unit stage.

c) Correlation coefficients for the post-study unit stage test and the terminal exercise of the practice and exercise unit stages.

### CC class

<table>
<thead>
<tr>
<th></th>
<th>WS2</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 16</td>
<td>PU3</td>
</tr>
<tr>
<td>N = 14</td>
<td>EX2</td>
</tr>
</tbody>
</table>

### ACC class

<table>
<thead>
<tr>
<th></th>
<th>WS2</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 18</td>
<td>PU3</td>
</tr>
<tr>
<td>N = 14</td>
<td>EX3</td>
</tr>
</tbody>
</table>

d) Correlation coefficients for the post-exercise unit stage test and the terminal exercise of the practice unit and exercise unit stages, and the post-study unit stage tests.

<table>
<thead>
<tr>
<th></th>
<th>WS3</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 14</td>
<td>EX2</td>
</tr>
<tr>
<td>N = 16</td>
<td>PU3</td>
</tr>
<tr>
<td>N = 18</td>
<td>WS2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>WS3</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 14</td>
<td>EX3</td>
</tr>
<tr>
<td>N = 17</td>
<td>PU3</td>
</tr>
<tr>
<td>N = 18</td>
<td>WS2</td>
</tr>
</tbody>
</table>

Table 6.21  Relation coefficients among workshop exercises and tests for CC and ACC students.

** P < 0.01    * P < 0.05    + P < 0.10
It is indicated in Table 6.21(a) that there was almost no relationship at all among three exercises in practice unit stage for the CC class. It was the same for the ACC class in the relationship between PU1—PU2 and PU1—PU3, and there was a statistically significant relationship between PU2 and PU3.

Correlation coefficients for the exercises in the exercise unit stage for the ACC class (see Table 6.21(b)) show almost an identical pattern to the previous one, i.e., initially low correlation and moderate correlation later. There was a statistically significant relationship between EX2 and EX3 for the ACC class. For the CC class there was no data on EX3 because of the change requested by the workshop teacher, and the number of students was as low as 10 in EX1 and EX2 due to some students not returning their grading sheets.

Correlation between the post-study unit stage test and terminal exercises for the CC class (see Table 6.21(c)) indicates very little relationship between WS2—PU3 and WS2—EX2. For the ACC class all relationships were at moderate level, and a statistical significance was found between WS2—PU3.

The relationship between the post-exercise unit stage test and two terminal exercises, and the post-study unit stage test for CC class, see Table 6.21(d), were very low and low. For the ACC class, on the other hand the relationships were moderate and low. There were two statistically significant relationships between WS3—WS2 and WS3—PU3 for ACC class.

All results shown above indicated general variations and unstabilized student status over successive practice and tests, as evidenced by negatively low, low or moderate correlations. This characteristic was very apparent for the CC class. In this case the implication is that the CC class contained students of similar ability in producing acceptable work, as variations of correlation in many stages were low and in a narrow range (-0.22 to 0.26). For the ACC class, statistically significant relationships were found occasionally in the post-study unit stage test and the exercises (i.e., WS2, PU3 and EX3). Variations of correlations were slightly wider than that of the CC class, in this case it was from 0.03 to 0.65.

Low correlation coefficients in production work were not unusual. These findings were similar to those discovered by Boxton and Humphreys (1935) in their study of four motor skills. Their
correlation was range from 0.08 to 0.4 in the beginning of the experiments and from -0.02 to 0.39 after practice.

Low correlation in production work, however, could be explained by two main reasons:

1. Every production work in this case (benchwork) was based on specific quality specifications by which measurement was considered as either good, fair or poor; and discrimination power of each quality measurement was not applicable. This characteristic of production work could be observed in similar low standard deviations on a number of exercises for both CC and ACC classes, see Table 6.22. The lack of variation in score distribution in turn resulted in low correlation coefficient.

2. Every student was liable to make a number of mistakes on production work. Once a mistake was made, in many cases, correction was impossible later. It is unlike a paper-pencil-test in which a mistake can readily be corrected several times. This characteristic of production work could be observed by variation on students' ranking status, see Table 6.22. The lack of rank stability for over many exercises resulted in low or negatively low correlation coefficients.
<table>
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<th>Student No.</th>
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| X | 98.50 | 70.40 | 179.00 | 241.80 | 239.40 | 223.60 | 441.30 |
| S.D | 9.60 | 2.01 | 6.61 | 18.10 | 2.20 | 6.63 | 29.90 |

Note: -9 = Students who did not return grading sheets

X = Scores
R = Rank from lowest to highest scores

Table 6.22 Scores and ranks of CC and ACC students on exercises in post-study unit stage test, practice unit stage, exercise unit stage, and post-exercise unit stage tests.
Based on research results the following conclusions could be drawn on factors that affect the ability in planning and production work:

1. Research results have shown that 59 to 65% of workshop knowledge other than technical drawing and benchwork theory account for the achievement in planning. This workshop knowledge is thought to be mainly in the planning exercises itself. There are reasons and evidence (see conclusion on section 2 item 4 as well) to convince teachers to implement planning activity along with workshop practice.

2. Research results have shown that workshop knowledge has little influence on the achievement of production work. Amongst this knowledge, knowledge of planning has the most influence on the achievement on production work. Technical drawing and benchwork theory have the least influence. However, these findings should not encourage teachers to ignore these subjects otherwise the achievement on production work might turn out to be not as good as they are now.

3. There are no statistically significant relationships to confirm that quick working (low production time) will diminish the achievement on production work in test situations. However, there are consistently low relationships between quick working and low level of achievement on production work.

4. Stability of student performances over successive practice on a number of production works was unstable, low correlations could be expected on a series of production works as due to student achievement was measured in terms of quality specification rather than norm reference, and mistakes on production work were likely to be uncorrectable.
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</table>

**Legend:**
- WS 2 = Post-study unit stage test
- FU 1 = Practice unit exercise 1
- PU 1 = Practice unit exercise 1
- EX 2 = Exercise unit exercise 2
- PU 2 = Practice unit exercise 2
- EX 3 = Exercise unit exercise 3
- PU 3 = Practice unit exercise 3
- WS 3 = Post-exercise unit stage

**Note:** * III very often.

Table 6.22 (cont.)
7.1 OVERVIEW

In the first semester both CC and ACC students attended a workshop course on brickwork and joint finishing. While other first year skilled worker students attended a course on benchwork practice. In this semester CC and ACC students attended the benchwork practice course, and only the first year skilled worker students from five classes continued this course.

During the first half of this semester the new workshop training system was implemented for both CC and ACC students, and the second half the traditional system was implemented.

In this chapter I will describe the working conditions imposed upon students under the new and the traditional systems. The main interest of this chapter will be students reactions to the new training system. It is necessary, however, to extend the study also to the traditional system, in order to obtain more comprehensive information. In this way a judgement could be made on the merits of the new training system compared with the traditional training system.

In this chapter I will present results of survey questionnaires on student attitude and perceptions of the activities, conditions, and/or material components used in both the new and the traditional training systems. The study was conducted from the pre-system stage until the end of the training course. It also included a comparative study into the degree of teacher involvement in student activities in the new and the traditional training systems in respect of student perceptions.

7.2 WORKING CONDITIONS UNDER THE TRADITIONAL TRAINING SYSTEM

It has long been a tradition in workshop training for every student to clock-in to and clock-out of the workshop. And prior to working, students will assemble together each morning and afternoon to listen to a talk from a teacher. Their attendance and uniform dress are checked and there is punishment in one form or another for those who disobey workshop regulations.
After these workshop talks the teacher allocates work to the students. A workshop practice exercise book (not the programmed workshop exercise leaflets of my design) is used for reference, containing drawings, lists of sequence of operations, and some illustrations of working techniques. However they are not arranged in the programmed form.

While the students are working, the teacher supervises and gives guidance and help to students. Students either work on their own or sometimes help each other. Students must work only during working hours and no rest or absence without permission is allowed. Every week each student must submit a report in a log book.

The teacher awards grades to students only on some of the exercises, but these grades are not revealed to students until the end of the course. There was no test in either workshop theory or workshop practice. The final grades are based on three main aspects: finished work, responsibility, and discipline and conduct.

7.3 WORKING CONDITIONS UNDER THE NEW TRAINING SYSTEM

There are many differences in the new training system from the traditional one. Here a student is free to come to the workshop at anytime. There are no clas assemblies, no attendance check, and no disciplinary punishment. A student can take a rest anytime or work during breaks or overtime. He can work and discuss with friends, but he may not actually help another in producing his work.

A student will be given a training guide which contains information about training aims and stages, network diagrams of topics and exercises involved, examples of programmed texts and programmed workshop exercise leaflets, and so on. He has complete freedom to choose any workshop exercises in relation to the given network diagrams.

The teacher will not give any demonstration or any workshop talk. The student must study his own programmed workshop exercise leaflets, i.e., study the drawings, sequence of operations, questions leading to planning, list of faults and remedies, illustrations of good/poor work, and the list for quality grading. In the exercise unit stage the student will plan his own sequence of operations and which tools to use, either by himself or in conjunction with others. The teacher will ask a student to explain his plan before giving a workstock and specifying a target time.
While the students are working, the teacher will visit them from time to time and give his advice or guidance. When the student has completed his work, he must measure and grade his own work according to the grading sheet, and then submit both to the teacher. The teacher will call the student later to discuss results and grades.

The student must complete the questions given in a report assignment and other activities (see an example in Appendix B 2) for every workshop exercise, and submit them within a week.

7.4 ORIENTATION TO THE NEW WORKSHOP TRAINING SYSTEM

My design of the new workshop training system was new to all students and it contained many important features and activities. Thus on the first day of the course I gave an orientation to the new workshop training system and the benchwork practice course for all CC and ACC students.

I spoke for an hour and a half about the aims of the workshop practice course, the aims of the four successive training stages and learning materials. The head of the workshop then spoke for half an hour about workshop regulations in general, and about safety and accident prevention.

Before the orientation every student was given the training guide as mentioned earlier. At the end of this meeting the first survey questionnaire was given to all students.

In the following I will present areas of my study, the rationale, construction and implementation of the questionnaires, the results and a discussion.

7.5 AREAS OF THE STUDY ON STUDENT ATTITUDES AND PERCEPTIONS TOWARDS THE NEW AND THE TRADITIONAL TRAINING SYSTEM

There were seven survey questionnaires which I had conducted into the following areas of study:

1. Student attitudes at the pre-system stage.
2. Student attitudes at the end of the study unit stage.
3. Student perceptions of the activities and components of the new training system.
4. Student attitudes and preferences as regards the new and
5. Student perceptions of the degree of teacher involvement in student activities in the new and the traditional training systems.

7.5.1 RATIONALE FOR THE STUDY OF STUDENT ATTITUDES AT THE PRE-SYSTEM STAGE

As CC and ACC students were both civil construction students, their occupations concerned construction in wood, brick and concrete. In the first semester they practiced their skills in brickwork and joint finishing. But in this semester they were to practice with steel and machine tools to produce machine components. Students in this situation might think that this kind of work could hardly be relevant to their intended careers. Thus, they might have formed negative attitudes toward the new workshop course. This proposition had to be investigated at a very early stage of the course.

Another aspect of student attitudes at this stage concerned the activities and conditions in the new training system. As individualized instruction was incorporated in this new training system, there were many elements of learning activities and conditions which were new and unfamiliar to students; for example, programmed texts, self-study, self-pacing, self-selection of learning topics, etc. Students might have either positive or negative attitudes towards these elements. This also had to be investigated.

It was plausible that student attitudes towards both the new course and the new training system might also be linked with their achievement and satisfaction in the previous workshop practice course. Thus, it would be appropriate at this stage to survey the state of student satisfaction with and the general atmosphere during the previous workshop practice course.

7.5.2 RATIONALE FOR THE STUDY OF STUDENT ATTITUDES AT THE POST-STUDY STAGE

In the study unit stage both CC and ACC students experienced five different learning methods and conditions: lectures, self-study with my programmed texts, in a classroom, the same self-study in the student's own time, self-study with commercial texts with solutions
given to exercises, and self-study with commercial texts with no solutions to exercises. The two highlights of the individualized system were the freedom in one's own style and the material in the study programmed texts. These were what distinguished it most from lectures and commercially available texts.

Studying under different teaching-learning methods and conditions a student should appreciate the differences and make his own evaluation. He might either prefer one to another or like both. Therefore, the study ought to be extended to the attitude of students as regards teaching-learning effectiveness and efficiency (the latter is already discussed in chapter 4). Thus, the weakness and strengths of the methods, material and conditions can be investigated and later improved.

7.5.3 RATIONALE FOR THE STUDY INTO STUDENT PERCEPTIONS TOWARDS THE ACTIVITIES AND COMPONENTS OF THE NEW TRAINING SYSTEM

The new training system contained many aspects - learning objectives, task enrichment, programmed texts, working conditions, etc. All these aspects were designed and constructed mainly to facilitate student self-learning and training in both workshop knowledge and skills. As many of these aspects were new to students on the one hand, and the system, including materials, was being tested for the first time on the other hand; thus, there might well be some weaknesses or limitations which needed improvement or modification.

One possible area of study to obtain information useful for this purpose were student attitudes and perceptions. In order to get accurate information the students themselves should have an opportunity to experience another equivalent situation. In the benchwork practice course, this would be possible if part of their study were conducted in the traditional training system, with this arrangement I believed that the students should have built up reference models in their perceptions in order to compare the two training systems, i.e., the new and the traditional.

Based on the above notion, I therefore conducted a survey of student perceptions of the activities, material and conditions in the new training system during that period when they were using the
traditional system. Since this survey was thus taken during the traditional system stage, I also extended its study to comparative student perceptions of the teacher's role and self-study in workshop practice.

7.5.4 RATIONALE FOR THE STUDY INTO STUDENT PREFERENCES AS REGARDS THE NEW AND THE TRADITIONAL TRAINING SYSTEMS

The new training system was purposely devised as an alternative system to the traditional one. Many elements of the new training system such as student activities, working conditions, learning aids or facilitators, etc., were designed and constructed to serve the same purpose or function as those of the traditional system, and sometimes to make up a deficiency therein.

It was realised that many elements of both systems could not be measured directly in quantitative terms, but indirectly in qualitative terms. In order to validate these elements of the new training system they were subjected to a comparison with those of the traditional system. This comparison was accomplished by means of the degree of student preference. This comparison is analogous to that made of the preferences for eating two different kinds of fowl, such as chicken and duck. Based on the average student preference, any element of the new training system which was superior to the rival traditional system, would be indicated by a higher preference and vice versa. Thus information obtained in this way was thought to be useful for later improvements and modifications to either the new or the traditional system.

7.5.5 RATIONALE FOR THE STUDY OF TEACHER INVOLVEMENT IN STUDENT ACTIVITIES IN THE NEW AND THE TRADITIONAL TRAINING SYSTEM

As stated in the problem analysis presented in chapter 1, one aim of the new training system was to minimize teacher loads. Having adapted the individualized system into my design, the new workshop training system then had elements by which students could study by themselves while the teacher acted merely as a facilitator. Thus, the teacher acquired the task of giving advice, supervising student work, discussing student problems, approving student plans and grading finished work, etc.
Basically, the degree of teacher's involvement in student activities should be as low as possible. But in reality it proved to be higher than one have anticipated. This had to be investigated. Any malfunctioning element as regards teacher involvement must eventually be corrected, improved or modified to achieve the purpose.

For the new training system there were four successive training stages, i.e., study unit stage, practice unit stage, consolidating unit stage, and exercise unit stage. The first and third stages are not found in the traditional training system, whereas the second and the fourth were almost identical in terms of the students' main activities.

In order to validate the new training system as regards the teacher's effort, a comparison of the two systems was made as regards the degree of teacher involvement in student activities. One possible method was by means of student judgement of the degree of teacher involvement. Another powerful method would be by a careful systematic observation of the amount of time spent by the teacher in each of the actual situations. The first method would provide no grounds for comparison between the new and the traditional system during the study unit and the consolidating unit stages. This would be due to there being no systematic and consistent topics given for students in the traditional system. This being the case a goal free basis was used in both the study unit and the consolidating unit stages.

Within the limit of my capability the survey study into the degree of teacher involvement in student activities was used. This involved two questionnaires, one administered to all students in the new training system and the other to a sample of student in the previous semester.

7.6 INSTRUMENTATION AND IMPLEMENTATION

All the survey studies described previously were carried out by means of questionnaires. In the following I will describe the techniques used in their implementation in the order in which they have just been presented.
This questionnaire involved three aspects: the students' previous workshop experience, student expectations from the benchwork practice course, and student attitudes towards the new training system.

The aim of the study in the first aspect was to gather information about student satisfaction with and about the general atmosphere of the previous workshop practice course (i.e., brickwork and joint finishing). The range of the study covered three areas.

1. Communication from the teacher to students in relation to learning aims and grading.
2. The state of learning achievement in workshop knowledge.
3. The state of the training atmosphere.

The aim of the study in the second aspect was to provide information as to the degree of student expectation from a number of the main learning/training activities and from relationships with friends and the teacher.

In the last aspect the study's aim was to provide information on student attitudes towards a sample of the aims, contents, learning conditions, activities, and learning criterion.

I anticipated that students at this level would not be familiar with questionnaires, but would be familiar with multiple choice test items as used in normal tests and examinations. Therefore, I adopted this method to construct the questionnaire for these three aspects. There were five possible answers provided for each question. These options were in fact a judgement scale ranging from low to high as shown in this example.

How much did you like report writing?

a) I did not like it at all  b) I did not really like it
c) I liked it moderately  d) I liked it a lot
e) I liked it very much.

For attitudes towards the new training system, some questions contained both 'pro' and 'contra' results. Thus, for each question...
two pro and two contra, and one open-ended options were provided as in the example shown below:

The new training system allows you to choose your own sequence of programmed texts or workshop exercises. What is your attitude to this?

a) It is very individual  
b) It is bothersome.  
c) I am not sure how to choose them correctly  
d) It is interesting.

e) Other (please specify) ____________________

This questionnaire was given to all CC and ACC students at the end of the orientation to the course (see also a schedule for implementation of other questionnaires in Table 7.1). Students were informed of the purpose of the study from this questionnaire and also were assured it would have no effect on their grades. They were allowed to complete this questionnaire at home and had to return it completed within two days. They were not required to enter their name on the questionnaire.
### Table 7.1 A schedule for implementation of survey questionnaires and interview

<table>
<thead>
<tr>
<th>Questionnaire/Interview</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Student attitudes at the pre-system stage.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Student attitudes at the end of the study unit stage, part 1 and 2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Student perceptions of the new training system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Student preferences between the new and the traditional training system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Teacher involvements in student activities in the new training system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Teacher involvements in student activities in the traditional training system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Periods of training systems**

- New training system
- Traditional Training System
7.6.2 THE SURVEY QUESTIONNAIRE INTO STUDENT ATTITUDES AT THE END OF THE STUDY UNIT STAGE

This survey was concerned with two main aspects: student attitudes towards the principles of individualized learning, and student perceptions of the structure of the programmed texts of my design.

The aim of the first aspect was to provide information on how students reacted to the main principles of individualized learning, which they had already experienced in the study unit stage. Meanwhile the second aspect had the aim of gathering information on how students would agree to the functions and roles of the material provided in programmed texts. Any unfavoured results would indicate areas of weakness which would need improvement and modification.

Since individualized learning was a completely different matter from the structure of the programmed texts, I separated them from each other in order to safeguard against any tendency of one matter effecting on another.

Students at this stage would be capable of making their own judgement. I, therefore, adopted a five point attitude scale, i.e., very favourable, favourable, undecided, unfavourable, most unfavourable, for the first questionnaire about student attitudes toward the principles of individualized learning. Given below are two example statements from this questionnaire.

What is your attitude to:

1. Choosing your own study programmed text.

2. Choosing your own study places.

<table>
<thead>
<tr>
<th>Most like</th>
<th>Like</th>
<th>Not sure</th>
<th>Dis-like</th>
<th>Most dis-like</th>
</tr>
</thead>
</table>

For the second questionnaire on student perceptions into the structure of programmed texts a five point agreement scale was used: strong agreement, agreement, undecided, disagreement, and strong disagreement. In order to safeguard against a student's tendency to score frequently on some particular option - both positive and negative statements were randomly arranged. Below are two example statements of this questionnaire.
1. The given network diagram enables you to choose your own programmed texts.

2. Good programmed texts must contain very detailed explanations.

The first questionnaire was given to all CC and ACC students at the end of the study unit stage and the second one five days later. Students were told about the purpose of the study and also assured there would be no consequences to their gradings. They were asked to return the completed questionnaires within two days and that no name should be entered on it.

7.6.3 THE SURVEY QUESTIONNAIRE INTO STUDENT PERCEPTIONS OF THE ACTIVITIES AND COMPONENTS OF THE NEW TRAINING SYSTEM

This questionnaire was constructed in order to determine weakness in activities and material provided in the new training system. These could be categorized in four main aspects:

1. Learning and training objectives.
2. Workshop knowledge.
3. Learning/training facilities.
4. Task enrichment.

To facilitate student response to this questionnaire, all aspects above were constructed in the same format and using the same
five point agreement scale as the previous one. In order to safeguard against any tendency to score high on particular options, both positive and negative statements were arranged randomly. An example of this questionnaire was given partly in section 4 of the example given below.

As already mentioned in the rationale (see section 7.5.3) for this survey questionnaire, the study was extended into a comparative study of student perceptions of the teacher's role and self-study. In this part a number of comparative statements about a sample of possible positive features in the teacher's role and self-study were provided. Two statements of this study are given in section E below.

A. Objectives

1. Learning objectives could motivate your study.

2. The content of the tests on workshop knowledge and practice skills should be made known in the objectives.

E. Comparative methods of training

40. It was easier to understand a lecture than to study by oneself with a programmed text.

41. It was much faster to study a programmed text than to attend a lecture.

I should point out that in actual questionnaire the section headings were not provided. This is to avoid any bias or contamination resulting from them.
This questionnaire was given to all CC and ACC students two weeks before the end of the course (see also the schedule for the implementation of survey questionnaire, Table 7.1). Students were asked to return the completed questionnaire within two days.

7.6.4 THE SURVEY QUESTIONNAIRE INTO STUDENT ATTITUDES TOWARDS THE NEW AND THE TRADITIONAL TRAINING SYSTEMS

The main purpose of this survey questionnaire was to determine student preferences between two comparative activities, events or conditions of both the new and the traditional training systems. By imposing a condition by which individual students had to choose between two rival activities, events or conditions one from each of the two training systems, then their preference on an average basis could be obtained.

This questionnaire was constructed by adapting the format of semantic differential (Osgood, et al., 1957) and a number of comparative activities, events or conditions of the two training systems. They were put randomly on opposite sides. A five point scale was used to determine both the degree of student preference and the direction/polarity of preference for any one activity, event or condition. The principle and example of this questionnaire is partly given below.

<table>
<thead>
<tr>
<th>Like</th>
<th>Neutral</th>
<th>Like</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

1. Study workshop theory in the classroom. Study workshop theory in other places.

If a student scored either 1 or 2, this indicated that he preferred studying workshop theory in the classroom. The score 1 or 2 indicated whether he had a strong likeness or not to studying in other places. If a student scored 3, it meant he was indifferent to the place of study. A score of 4 or 5 would indicate a moderate or strong (respectively) preference for studying in other places than the classroom.
This questionnaire was given to all CC and ACC students two days before the end of the course. Students were asked to return the completed questionnaire on the first day of the final examination.

7.6.5 THE SURVEY QUESTIONNAIRE ABOUT TEACHER INVOLVEMENT IN THE NEW AND THE TRADITIONAL TRAINING SYSTEM

The purpose of this study was to provide descriptive information about the degree of teacher involvement in student activities in the new and the traditional training system. This information would be used for validating the new training system in terms of the teachers effort in relation to those in the traditional system.

Two questionnaires were constructed in this study, using the same format. The first questionnaire was used for all CC and ACC students, and the second one for a sample of 40 students out of 100 previous semester students who were still working in the workshop in the second semester. The rationale for two separate survey in this case is already discussed in section 7.5.5.

The first questionnaire contained a number of the main student activities in the four training stages, i.e., study unit stage, practice unit stage, consolidating unit stage, and exercise unit stage. Whereas the second one contained almost identical activities to the practice unit stage and the exercise unit stage. This was due to the same workshop exercises (i.e., the U-shaped work and the small vice project) being used in both systems.

The degree of teacher involvement was judged on the basis of student perceptions of a four point scale: high, fair, low and none. The example given below shows only a small part of the first questionnaire on the new training system.

Please state the degree of teacher involvement in

A. Study unit stage.

1. Choosing study unit topics,

2. Studying study unit topics.

<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>Fair</th>
<th>Low</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The questionnaire for CC and ACC students was given on the middle of the second half of the semester and the one for a sample of the previous semester students five days later (see Table 7.1).

7.7 ANALYSIS OF RESULTS

Student responses to each questionnaire were ranked on an ordinal scale. The analysis of these results could be made in two possible ways: either in terms of response modes (majority) or response average (mean). The choice would depend upon the purpose of discussions and presentations of results. Table 7.2 below indicates the methods used in presenting summary of results of all questionnaires conducted in my study.

<table>
<thead>
<tr>
<th>I. Response modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Student attitudes at the pre-system stage.</td>
</tr>
<tr>
<td>2. Student attitudes towards the principles of individualized learning.</td>
</tr>
<tr>
<td>3. Student attitudes towards the structure of study programmed texts.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>II. Response average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students perceptions of the new training system.</td>
</tr>
<tr>
<td>2. Student preferences between the new and the traditional training system.</td>
</tr>
<tr>
<td>3. Student perceptions of teacher involvement in student activities in the new and the traditional training systems.</td>
</tr>
</tbody>
</table>

Table 7.2 Choice of methods of presenting summary of results of all survey questionnaires used in the study.
Since there might be a relationship between groups of students and choice of responses (questionnaire's scale), the Kolmogorov-Smirnov formulae were used in either the one sample test or the two sample test. The examples of these statistical analyses are given in Appendices D2 a and b. The assumption governing the use of the Kolmogorov-Smirnov is that the underlying dimension is continuous and that the data are at the nominal level of measurement. Siegel (1956) suggests that for small samples the Kolmogorov-Smirnov test relative to the t-test has a power efficiency of approximately 96% and compared with the chi-square two sample test is more powerful in all cases.

In some occasions a number of items asked in the questionnaire needed to be combined together under particular categories. For example, three items dealing with objectives were combined together under 'learning objectives'. In this circumstance the scale used for negative statements was changed in opposite direction to that of the positive statement, i.e., from 1 2 3 4 to 4 3 2 1. Then the sum of average response frequency of these items was averaged. The result obtained indicated the overall average of student responses in that category.

7.8 RESULTS AND DISCUSSIONS

I will present the results of all the survey questionnaires together with their discussions in the following order.

1. Student attitudes at the pre-system stage.
2. Student attitudes towards the principle of individualized learning and the structure of study programmed texts.
3. Student perceptions of the activities and material of the new training system.
4. Student attitudes and preferences towards the new and the traditional training systems.
5. Student perceptions of teacher involvement in student activities in the new and the traditional training system.

7.8.1 RESULTS OF STUDENTS' ATTITUDES AT THE PRE-SYSTEM STAGE

16 out of the 20 students in the ACC class and 10 out of the 18 students in the CC class returned the completed questionnaires.
distributed at the pre-systen stage. The result of student response
distribution to three parts of this questionnaire is given in
Appendix E4.

From the overall inspection of student response distributions
it was found that students of both classes on many occasions opted
for the middle of the scale of alternatives. This may probably be
due to either students surely judged it at that level or they had
formed a tendency to choose the middle in case of uncertainty. The
later could probably be explained as they were unfamiliar with making
judgement of that kind of cases, or lacking of impression and
perception of the cases concerned. To safeguard against misinterpre­
tation the range of student responses will also be taken into
account. I should also point out that there were no statistically
significant differences on responses distribution between the two
classes.

In the following I will present the summary of the results
and the discussions of this questionnaire in three separate parts:
students' previous workshop experience, student expectations of the
benchwork practice course, and student attitudes towards the new
training system.

a) Students' previous workshop experiences

There were twelve items in this part of the questionnaire.
Items 1 to 4 could be regarded as concerning communication from the
teacher to students on learning aims and grading.

From the results of these items in Appendix E4 the following
were found:

1. Many students (i.e., 30% and 50% of the CC and ACC students
respectively) thought they knew moderately well about
grading finished work. Many other students (i.e., 40%
and 38% of the CC and ACC students respectively) thought
they knew a little about it. While the rest considered
either knew it well (6%) or not at all (30 and 6%).

2. Many students (50% and 38% of the CC and ACC students
respectively) thought they knew moderately well how the
final grading was done. While many others (30% and 40%
respectively) thought they knew a little. And the rest felt that either they knew well (12%) or not at all (20% and 6%).

3. The majority of students in both classes (60% and 63% of the CC and ACC students respectively) thought they knew moderately well about the aims of the previous workshop practice course. While some thought they either knew it well (20% and 6% respectively) or only a little (20% and 12%), and finally a few either thought they knew it very well (6%) or did not know about it at all (12%).

4. The majority of students of both classes (50% and 63% of CC and ACC students respectively) thought they knew moderately well the aims of report writing. Some others either thought they knew them well (19% for both classes) or a little (20% and 12%), and the rest thought they knew them either very well (20% for both) or did not know about it at all (10% and 6% respectively).

From the above summary it was found that items 1 and 2 had almost identical results; i.e., the responses were negatively-skew distributed, ranging from ignorance to considerable knowledge. For items 3 and 4, the responses were normally distributed through the same range. The first set of results indicated clearly enough the lack of communication from the teacher to students on learning aims. Good communication would have resulted in the response distribution in the above two cases being positively-skewed and the range was very narrow. The first finding seems to support the conclusion presented earlier in section 7.2 (working conditions under the traditional system) that the teacher only awarded grades to the students' completed work and thus no feedback was given until the end of the course. The second finding is probably due to insufficient explanation or orientation about the aims of the course and report writing being given to students, or due to no manual on this matter being given.

Item 5 concerned feedback to areas of student weaknesses and strengths. The result for this item can be stated as:

-the majority of students either thought they knew the areas
of their own weaknesses and strengths either moderately well (40% and 38% of the CC and ACC students respectively) or quite well (40% and 50% respectively). The rest either thought they knew them very well (10%) or only slightly (10% and 12%).

This result was normally distributed on the positive side. This indicated adequate communication in this matter. This can probably be explained from two points of view. Firstly, the teacher during his supervision might have informed students about their weaknesses or faults. Secondly, the students themselves might have been aware of these externally from the appearance of their workpieces, or internally from their feelings and senses while they performed the tasks.

Items 6 and 7 concerned workshop knowledge. The results of these items were almost identical and normally distributed about the middle of the scale (see results in Appendix E4). These results indicated that on average the majority of students of both classes knew moderately well about the principles of selecting tools and about the working techniques for their work. These results were of course judged by the students themselves and were more-or-less similar to the results normally found in paper-pencil tests. This result means that the students’ workshop knowledge was adequate. However, I would have thought that their knowledge should have been more, on average, on the positive side; i.e., towards 'good' or 'well'. This implies that there should be an effort to improve students workshop knowledge, even though it could not be said to be inadequate.

Item 8 concerned the state of student feelings towards their work. The results from the response distributed indicated that

-the majority of students of both classes (70% and 80% of CC and ACC students respectively) moderately enjoyed their work. Many others (30% and 38% respectively) even enjoyed it much, and the rest very much.

This result indicated clearly that in general students were satisfied with their work. It was conceivable that there were many aspects contributing to satisfactory working, such as progress in acquiring skills or successful completion of work. There are a number of theories such as achievement motivation, or the hygiene theory which suggest successful results and achievement contribute to 'good' feelings.
The results from the response distribution for item 9 indicated that

many students (60% and 38% of CC and ACC students respectively) liked report writing. Others (10% and 44% respectively) liked it only a little, and others either liked it very much (20%) or did not at all (10% and 12%).

The result was negatively-skew distributed toward the negative side. Thus the pattern of response distribution was found to be similar to that in item 4 about the state of communication on the aims of report writing. This implies a positive correlation between the state of communication on aims of report writing and student attitudes on this task.

Items 10 and 12 need to be viewed together. The results of response distribution on these items indicated that

many students (50% and 44% of CC and ACC students respectively) liked competitive working with friends. While some others (40% and 12% respectively) only liked it a little, and the rest either quite liked it (25%) very much (10% for both) or did not like it at all (19% for both).

most students (70% and 44% of CC and ACC students respectively) sought help or exchange ideas with friends during work moderately often. Some did so very often (10% and 31%) others rarely (10% and 19%) and some did not at all (10% and 6%).

The response distributions of both results were similar and normally distributed ranging from 'not at all' to 'very much'. This indicated that students of both classes on average did like working co-operatively and competitively. The range of responses indicated that there were a wide range of individual differences among students in both classes in respect to mode of working. This also implies a free working atmosphere rather than strict and rigid stationary working.

Item 11 concerned flexibility in working hours. The response distribution in this item was:

many students (50% and 63% of CC and ACC students respectively)
rarely worked overtime. Some (20% and 25% respectively) worked overtime at all, while the rest either worked overtime moderately often (20% and 12%) or very often (10% for both).

This result indicated that overtime working was not restricted even though it was not encouraged.

From all the findings discussed above the overall conclusion of the students' previous workshop experiences could be drawn as follows:

1. There was a lack of communication from teacher to students regarding learning aims and grading.
2. There was no lack of feedback about areas of student weaknesses and strengths in practical work.
3. There was no lack of workshop knowledge in students but an improvement might be needed.
4. Students enjoyed practical work.
5. There was a lack of interest in report writing.
6. Students preferred co-operative and competitive working.
7. There was no strict prohibition of overtime working.

b) Results on student expectations from the benchwork practice course

There were seven items concerning student expectations from benchwork practice course. The range of contents covered—grades to be obtained, knowledge and capability, the mode of working with a colleague and the relation to the teacher. I will present in the following the results and the discussion of each item. The response distribution of this part is given in part B of Appendix E4.

The results for item 1 indicated that most of the students (60% and 69% of CC and ACC students respectively) expected a 'B' grade on this course. Others (40% and 25% respectively) expected an 'A' grade. Only 6% of CC students expected to get 'C' grade. This implies that the majority of students expected very high grades on this workshop practice course. Referring to the students' previous state of workshop theory knowledge, working modes and working
satisfaction (see the conclusion above), I would accept that there was grounds for their high ambitions.

Items 2 to 5 should be viewed together. The students' response distribution for these items shows that:

- Most students (60% and 50% of CC and ACC students respectively) were moderately confident of being able to plan the sequence of operations. Some others (30% and 31% respectively) were very confident, and the rest either had total confidence (12% for both) or did not expect to be capable of it at all (10% and 6%).

- Most students (70% and 69% of CC and ACC students respectively) were confident that they were knowledgeable in workshop theory. Others (20% and 19% respectively) were moderately confident, the rest either were totally confident (12% for both) or had no confidence in their knowledge (10% for both).

- The majority of students (90% and 94% of CC and ACC students respectively) were moderately confident of being capable of producing acceptable work. While the rest (10% and 6% respectively) were totally confident of this.

- The same response pattern to the preceding one was found on the capability to solving working problems.

From the results above the levels of expectations can be ranked on the response average basis, as follows:

1st. knowledge of workshop theory.
2nd. ability to plan a sequence of operations.
3rd. ability to produce acceptable work, and ability to solve working problems.

Having compared the expectation levels on workshop theory in this course with those in similar workshop theory (items 6 and 7) in the previous course, it was found that the former were higher. This means that student expectation for workshop theory in this course was higher than the previously obtained achievement.
Item 6 concerned the working relationship with friends. The result of the response distribution was:

-many students (50% of both CC and ACC students) had only a slight wish to have friends working with them. Other (40% and 25% of CC and ACC students respectively) were moderately keen to have them and the rest (10% and 19% respectively) were desireous of them and 6% of both groups were even extremely desireous of them.

The results above indicated that for most students in both classes there was only a slight or moderate preference for working closely with friends. This did not mean they would not like to work co-operatively, but rather that most of them would prefer independent working.

Item 7 concerned the relationship with the teacher. The response distribution indicated that

-some students (40% and 38% of CC and ACC students respectively) had moderately desire to be admired by the teacher. Others (40% and 19% respectively) would have only a slight desire of this, and 10% and 25% respectively did not want it at all, whereas the rest (10% and 12%) wanted it a lot and even 6% of both very much.

It can be seen that there was a wide range of different attitudes toward the need to be admired by the teacher. This does not mean that many students disliked or hated the teacher, but rather the result seems to suggest that many students of both classes were self-reliant.

From all the results above the following conclusions can be drawn about student expectations from the benchwork practice course.

Many students of both classes had...

1. high ambitions in achievement grades.
2. high ambitions in workshop knowledge.
3. moderate ambitions in workshop abilities.
4. relatively little dependence on others.
5. considerable self-reliance.
Results on student attitudes towards the new training system

This part of the questionnaire consisted of eight items, covering contents and course arrangement, features of individualized learning, achievement criteria, and task enrichment. The results of the student response distributions are given in part C, Appendix E4. The first three items concerned student opinions on course arrangement. The response distribution indicated that

- some students (30% and 31% CC and ACC students) thought producing a small vice was interesting. While many others (50% of both respectively) thought it was very interesting. But some students (10% and 12% respectively) thought it was not interesting, and the rest expressed no opinion.

- almost every student of both classes thought, five successive training stages of the new training system was interesting if not very interesting. Only 6% did not find it interesting.

- all students in both classes found the objective stated as to enable students to plan a sequence of operations made for moderate if not great interest.

The results above indicated that almost every student of the two classes had strong positive attitudes towards the allocated project work, the stages of training and a sample of training objectives. This might probably be due to the following reasons:

- they were very docile students.
- they wanted to please the author.

The response distribution on item 4 indicated that

- many students (50% and 45% of CC and ACC students respectively) thought choosing their own sequence of topics greatly helped individualism, while others (33% and 20% respectively) thought it interesting. However some students (17% and 15%) thought it was bothersome and the rest (20% of the ACC group were not sure how to choose the sequence correctly.
This result shows that the majority of students of both classes viewed this task positively, although some did not like it or feel certain about it.

The response distribution on item 5 indicated that
~some students (36% and 27% CC and ACC students respectively)
thought studying a number of lessons on their own greatly helped individualism, while some others (28% and 32% respectively) thought it was good to work closely with friends. But some students (28% and 32% respectively) thought it would be difficult to understand, and a few (8% and 9% respectively) were afraid of not being able to keep up with friends.

These results show that many students had positive attitudes on this activity, although at the same time some were lacking confidence and were slightly worried about their learning. The latter point reveals the fact that this method of learning was new to them.

For item 6 the response distribution indicated that
~some students (36% and 32% of CC and ACC students respectively)
thought by allowing good students to go on without waiting for others was good as they could learn more, while others (9% and 37% respectively) thought one would not waste one's time. However some others (27% and 16% respectively) thought that this might cause a bad rivalry between friends. And the rest gave contradictory opinions such as 'poor students might get bored', 'it discriminated between friends', and 'it makes one to improve oneself'.

The results shows that about 50% students had positive attitudes on self-pacing whilst other did express reservations. The latter point implies that many students prefer to make progress with others.

On item 7 the response distribution indicated that
~many students (55% and 50% of CC and ACC students respectively)
thought that the 60% achievement criterion for passing the study unit stage was a good standard, while some (9% and 20% respectively) thought it was very challenging. However, some students (9% and 20% respectively) thought it was too hard, and 9% of the ACC students thought it might cause undue dismay.
Some students (18% and 10% respectively) expressed other opinions such as 'they never were sure about themselves', they would try their best', and 'it would be an indicator of diligence'.

The result shows that many students accepted the stated criterion for achievement level, which some (probably poorer) students thought it was too hard.

The response distribution on item 8 indicated that all students of both classes agreed that grading their own finished work could be useful.

From all results presented above the following conclusions can be drawn.

1. Almost all students of both classes had very positive attitudes towards the course arrangement in the new training system, i.e., the project work, stages in training, a sample of training objectives.

2. The majority of students of both classes had positive attitude to choosing their own sequence of topics.

3. Many students of both classes had positive attitudes on studying lessons on their own, even though some students were uncertain.

4. About half of the students in both classes had positive attitudes on self-pacing, while some (not all) others did not like it.

5. Many students in both classes accepted a 60% criterion level for passing the study unit stage, although some thought it was too hard.

6. All students in both classes absolutely agreed that self-grading on their finished work was a useful activity.
UNIT STAGE

This survey study consisted of two separate questionnaires. The first questionnaire was on student attitudes towards the principles of individualized learning, the second one on student perceptions of the structure of the study unit programmed texts. The first questionnaire was administered at the end of the study unit stage, twelve days from the beginning, the second one was five days later.

I will present in the following results and discussion of these two questionnaires.

a) Results on student attitudes towards the principles of the individualized learning

30 out of 37 CC and ACC students returned the completed questionnaires. One ACC student who was ill and had to retire from the course was not taken into account. The results of response distribution given in Appendix E5 (a) show both the number and percentage of student responses. There were no statistically significant relations between student choice and response scale, as computed with the Kolmogorov-Smirnov one-sample test.

The following are a summary of the results of students' attitudes on ten features of the individualized learning adopted in the study unit stage.

1. All but one indecisive student liked choosing their own study unit programmed text.
2. All but one indecisive student liked choosing their own place of study.
3. All but two indecisive students liked choosing the time at which they studied.
4. 80% CC and ACC studented liked studying their own study unit programmed texts. But one student did not like it, and 17% were not sure.
5. 70% CC and ACC students liked checking their own progress/weaknesses. 10% of students did not like it, and 20% were not sure.
6. 50% of CC and ACC students liked to pass over those sections of a programmed text which they had already covered
20% did not like this and 30% were not sure.

7. 53% of CC and ACC students liked to make progress at their own pace without waiting for or keeping up with others, 17% disliked it, and 30% were not sure.

8. 73% of CC and ACC students liked pursuing a programmed text until completion the stated learning objectives, whereas the remaining 27% of students were not sure.

9. All but two indecisive students said they liked choosing their own peers.

10. All but one indecisive student liked reviewing their own programmed texts.

From the results above it can be seen that in most cases the majority of students (more than 70%) had positive attitudes towards all the principles of the individualized learning; except passing over sections which they had already covered, and self-pacing. These very positive results could be explained as being due to the attractiveness of many freedoms found in the system. These features would appear to be congruent with the preferences of most students. This might only be because there was no threat of any kind imposed upon them. The conditions in the study unit stage conformed to the second order needs of Maslow's theory (i.e., safety needs).

The low number of students in favour of passing over sections which had already been covered, could be explained on the grounds that they might have thought it could speed up their learning. But the 20% students could probably not agree with this merit, because they disliked this feature of the system. One possible reason might be that students thought there was some value to be gained from study-in those particular parts.

The result on self-pacing was not so convincing at this stage as it was at the pre-system stage. Virtually the same percentage of students favoured this feature at both stages. This means that some students were still very conservative.

Some heightened attitudes were found at this stage towards choosing one's own study unit topics (an increase from about 40% to 97%) and towards studying one's own programmed texts (an increase from about 30% to 80%). These results are quite convincing, and could
probably be explained by students who were not quite sure of themselves at the beginning on these activities finding them easier to carry out successfully as they progressed with their studies.

Now I turn to the aspect of self-checking progress and weaknesses. Previously all students thought self-grading of their finished work as a useful activity. This time 70% of students preferred self-checking of their progress/weaknesses. A direct comparison between this activity in the two stages could not be made, since the subject matter was different in each case. The former concerned about workshop production while the latter workshop theory. The contrast could possibly be better stated as a large number of students at this stage preferred self-checking when studying workshop theory, but it was not as large as the possible potential found previously for workshop production. A plausible reason for the 20% of students who were not sure and 10% who disliked this activity could be a preference to read on uninterrupted and without bothering to look back to see whether they had understood what they had read. Another possible reason might be that they found this activity fussy or did not understand much from the given solutions to exercises or tests.

The result here on choosing their own peers was very positive. Previously it was found that many students had only a slight desire to have friends working beside (see item 6, part B of the previous questionnaire). This might imply that this activity or freedom was congruent with their potential personality as independent students. Other features of individualized learning which offered this similar sort of freedom were the free choice of study place, and the self-review of programmed texts (or lessons). Student attitudes to these features were very positive.

The conclusions which I thus draw from the above results are as follows:

1. The majority of students (more than 70%) had positive attitudes to almost all the features of individualized learning adopted in the study unit stage.

2. Positive attitude changes over the study unit stage occurred with some students (about 50%) as regards choosing the sequence of topics, and self-study on programmed texts.

3. Unchanged and low positive attitude existed towards self-pacing.
4. Passing over sections of a programmed text which had been covered already was preferred by about half of the total body of students.

b) Results on student perceptions into the structure of the study unit programmed texts

33 out of 37 CC and ACC students (89%) returned the completed questionnaires. The results of the student response distribution given in Appendix E5 (b). show both the numbers and percentages of students on a five point agreement scale. It was found that there were no statistically significant relations between student choices and the agreement scale.

I will present in the following a summary of results and the discussions of ten items on student perception into the structure of the study unit programmed texts.

From the student response distribution the following are a summary of results.

1. 85% of CC and ACC students agreed that the given network diagram enabled them to choose their own programmed texts. 15% of students were undecided.

2. 39% of CC and ACC students did not agree that good programmed texts should contain very detailed explanations. 30% of students were undecided and another 30% of students agreed that they should.

3. All but one student agreed that illustrations given in programmed texts facilitated their understanding of the contents concerned.

4. All but one student agreed that the exercises given in programmed texts enhanced their understanding of the contents concerned.

5. 37% of CC and ACC students did not agree that solutions given to exercises in programmed texts were unnecessary. 21% of students were undecided, and 12% did agree.

6. 85% of CC and ACC students agreed that results from the post-test were useful indicators of their learning
achievements. 15% of students were undecided.

7. 76% of CC and ACC students agreed that a programmed text should include a pre-test, 6% disagreed, and 18% were undecided.

8. 73% of CC and ACC students agreed that a pictorial sequence of operations in practical exercises facilitated their practice, of the rest all but one indecisive student disagreed with this.

9. 76% of CC and ACC students agreed that pictorial illustrations of the completed work were useful. The remaining 24% were undecided.

10. 42% of CC and ACC students did not agree that the practical exercises given in each programmed text enhanced their understanding of the preceding content. 30% of students were undecided, and 27% did agree.

From the results above it can be seen that in general most students responded positively to all positive statements, but varied over the range of responses to the negative ones. One cannot rule out the tendency that students scored frequently either on one particular side or only on positive statements, although some students did choose the neutral position as well as the negative ones on many items. The results on the negative statements gave another supportive indication to this matter that students read the given statements carefully. Thus, I am inclined to have confidence in the merits of the results obtained.

The positive result in item 1 above could probably be explained as being due to students being successful in choosing and borrowing their own programmed texts. The process of doing this required students to refer to the network diagram. Even in the situation where there were not enough learning aids available, the students would still have other alternative topics to choose from as laid down in the diagram. Without the provision of the network diagram the students would know which topics were available unless the teacher told them.

For item 2, students gave differing opinions from the whole range of responses. This indicated that a good programmed text for
some students must contain very detailed explanation, for others this is not so. This reveals the aspect of individual differences. It was not clear at this stage whether there was any association between the type of students and the amount of information desired in the programmed texts. But the result does imply, however, that different students do need varying amount of information. A good programmed text, in respect of the amount of information given, should therefore contain enough information for some students, while at the same time it must build-in mechanisms which suit other students who need less information. The mechanism adopted in programmed texts of my design was a directive given to the solutions for the pre-test which suggested able students could pass over some parts of material.

Items 3 and 4 concerned learning aids and exercises provides in the programmed texts. The results above indicated that students clearly recognized the role of illustrations and exercises given in programmed texts in facilitating and enhancing their learning.

The results of item 5 seems to indicate that the majority of students (67%) were in favour of solutions being given to exercises rather than being left out. The experiments discussed in chapter 4 on self-study methods with commercial texts both with and without solutions to exercises indicated both provisions have virtually the same effectiveness and efficiency. From the point of view of common sense, I would say that solutions being given to exercises would be beneficial for students who may need it, whereas other students may ignore them if they so desire.

Items 6 and 7 concerned a role of the post-test and student preferences in the pre-test. The results above indicated that the majority of students (about 85%) were in favour of the provision of both the pre-test and the post-test. The plausible reason why the solutions given to the post-test could form an indicator of learning achievement is that the post-test was usually equivalent to the pre-test. Thus any difference in scores between the tests would indicate the student's progress. Consequently the pre-test was a necessity. This is probably the reason for the positive result on item 7.

Results for items 8 and 9 indicated that the majority of students (about 73%) realized the value of the pictorial sequence of operations and illustrations of completed work given to practical
exercises in a study unit programmed text. Those students who were not uncertain about their merit, probably experienced difficulties in the exercises. As I have already discussed this in chapter 6 in relation to some difficulties of students in the use of the saw and chisel.

Item 10 had a wide range of different responses. Some students did not agree that practical exercises enhanced their understanding of the theoretical contents of the study unit programmed text. This might depend on the practical exercises themselves. Some practical exercise, such as clamping a workpiece in a vice, might demand more motor skills than cognitive skills. In this case it could well be true that the exercise did not enhance student's understanding. For other exercises like measuring the centre distance of the two holes, a student would need some calculations in addition to measuring activity. This could probably account for the view of those students who agreed with the statement on item 10.

From the above results I draw the following conclusions.

1. Most students had recognized the role and merit of almost all the components in the programmed texts. These components included a network diagram, illustrations of the written information, pre-test and post-test, exercises, a pictorial sequence of operations and illustrations of completed work.

2. Students had a wide range of opinions on the amount of information needed in the programmed texts.

3. Solutions to exercises should be included.

4. Practice exercises can sometimes enhance the student's understanding of theoretical knowledge.

7.8.3 RESULTS OF STUDENT PERCEPTIONS OF ACTIVITIES AND COMPONENTS OF THE NEW TRAINING SYSTEM

12 out of the 18 CC students and 13 of the 19 ACC students returned their completed questionnaires on student perceptions of the activities and components of the new training system. This number of returned questionnaires was a little lower than the 80% I would have expected. This might be due to some students being busy with their
homework or preparation for the final examination. From results in the previous questionnaires I venture to suggest that students who did not return their questionnaires would have opinions similar to those discussed in the following.

Contents in this questionnaire were divided into four parts: objectives, workshop knowledge, learning/training facilities, and task enrichment. The results of the student response distribution for this questionnaire are given in Appendix E6. It was found that there were no statistically significant relations between either classes of students and the response scale, using the Kolmogorov-Smirnov two sample test.

By combining a number of items which deal with the same aspect, I have arrived at eleven aspects of activities and components of the new training system. The relationship of items and aspects is given in Table 7.3. The method used in combining items has already been discussed in section 7.7. The grand averages of these eleven aspects are given in Table 7.4. The response scale of this table has the following meanings:

1 and 2 or 'strongly agree' and 'agree' = positive perception.
3 or 'undecided' = neutral perception.
4 and 5 or 'strongly disagree' and disagree = negative perception.

<table>
<thead>
<tr>
<th>Aspects of activities and components</th>
<th>Combination of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Learning objectives</td>
<td>1 to 3</td>
</tr>
<tr>
<td>2. Workshop knowledge</td>
<td>4 to 11</td>
</tr>
<tr>
<td>3. Pictorial quizzes</td>
<td>12 and 13</td>
</tr>
<tr>
<td>4. Questions leading to planning</td>
<td>14 to 17</td>
</tr>
<tr>
<td>5. Pictorial sequence of operations</td>
<td>18 to 20</td>
</tr>
<tr>
<td>6. Faults and remedies guide</td>
<td>21 to 24</td>
</tr>
<tr>
<td>7. Illustrations of good/poor work</td>
<td>25</td>
</tr>
<tr>
<td>8. Planning of sequence of operations</td>
<td>26 to 28</td>
</tr>
<tr>
<td>9. Grading sheets</td>
<td>29 to 32</td>
</tr>
<tr>
<td>10. Grading activities</td>
<td>33 to 37</td>
</tr>
<tr>
<td>11. Report writing</td>
<td>38</td>
</tr>
</tbody>
</table>

Table 7.3 Combination of items into aspects of activities and components in the new training system.
Table 7.4 Summary of results on students' perceptions into activities and components of the new training system.

<table>
<thead>
<tr>
<th>COMPONENTS</th>
<th>Students' attitudes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x</td>
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<tr>
<td></td>
<td>SA 1</td>
</tr>
<tr>
<td>1. Learning objectives</td>
<td>2.4</td>
</tr>
<tr>
<td>2. Workshop knowledge</td>
<td>2.1</td>
</tr>
<tr>
<td>3. Pictorial quizzes</td>
<td>2.6</td>
</tr>
<tr>
<td>4. Questions leading to planning</td>
<td>1.7</td>
</tr>
<tr>
<td>5. Pictorial sequence of operations</td>
<td>2.7</td>
</tr>
<tr>
<td>6. Faults and remedies guides</td>
<td>2.3</td>
</tr>
<tr>
<td>7. Pictorial illustrations of good and poor works</td>
<td>2.9</td>
</tr>
<tr>
<td>8. Planning sequence of operations</td>
<td>2.3</td>
</tr>
<tr>
<td>9. Grading sheets</td>
<td>2.7</td>
</tr>
<tr>
<td>10. Grading activities</td>
<td>1.9</td>
</tr>
<tr>
<td>11. Report writing</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Note: SA = strongly agree  
A = agree  
UD = undecided  
D = disagree  
SD = strongly disagree

--- CC students  
--- ACC students
The summary of results in Table 7.4 shows perception of both CC and ACC students, based on a grand average, for the eleven aspect of the activities and components of the new training system. It was found that CC students had clear positive perceptions (their grand average being no lower than 2.5) on learning objectives only, and an unclear negative tendency (their grand average being no higher than 3.5) on planning a sequence of operations, and for all the other aspects they had unclear positive perceptions (within the neutral zone). On the other hand ACC students had clear positive perceptions of:

- learning objectives.
- workshop knowledge.
- pictorial quizzes.
- questions leading to planning.
- pictorial sequence of operations.
- planning the sequence of operations.
- grading sheets.
- grading activities.
- report writing.

and unclear positive perceptions of:

- fault/remedy guides.
- pictorial illustrations of good/poor work.

For both classes there were no negative perceptions of any activities or components of the new training system. This implied that in general all designed activities and components provided in the new training system were acceptable, as far as CC and ACC students were concerned.

The results found above are crucial. This is because the survey was conducted at the end of the training course, and all CC and ACC students had by that time also experienced the traditional training system. This means that this terminal result was obtained from students of sufficient experience. Thus the result could be regarded as trustworthy. More details of the results and the discussions will be given in the following.

Positive student perceptions on learning objectives resulted from positive results regarding three elements. Firstly most CC and ACC students (67% and 77% respectively) had positive perceptions of
learning objectives which could motivate their study. Secondly most CC and ACC students (75% and 62% respectively) had a positive perception that their learning would be much improved if objectives were given. And finally some CC and ACC students (25% and 75% respectively) had a positive perception that the content of tests in workshop knowledge and workshop practice could be derived from the stated objectives. All these implied that students had realized the value of learning objectives in their learning/training system.

Positive student perceptions on workshop knowledge resulted from perceptions of eight elements as shown in the following.

1. 83% and 100% of CC and ACC students respectively had positive perceptions that knowledge of workshop theory could partially enhance their safe working.

2. 83% and 100% of CC and ACC students respectively had positive perceptions that the knowledge learned from workshop theory could facilitate workshop practice.

3. 75% and 77% of CC and ACC students respectively had positive perceptions that practicing without prior study of workshop theory could be a principal cause of erroneous working.

4. 25% and 77% of CC and ACC students respectively did not agree that their confidence would have been greater if they had practiced workshop skills without any study of workshop theory.

5. 33% and 92% of CC and ACC students respectively did not agree that studying the use of tools and production processes was a waste of time.

6. 42% and 69% of CC and ACC students respectively did not agree that knowledge learned in study unit topics was not beneficial in solving workshop problems.

7. 8% and 62% of CC and ACC students respectively did not agree that their efficiency working was dependent solely upon successive practice on actual exercises.
8. 42% and 85% of CC and ACC students respectively did not agree that studying workshop theory on the use of tools, equipment and production processes prior to actual workshop practice was unnecessary.

The results above indicated that many or even most CC and ACC student had on many aspects perceptions of the role and value of workshop knowledge and at the same time disagreed with all statements tending to diminish the role or value of the workshop knowledge. This implied that the workshop knowledge given to these students in the study unit stage was considered to have a role or value beneficial to the students of this course.

Positive student perceptions of the pictorial quizzes provided in consolidating unit stage resulted from the following two elements.

1. 50% and 77% of CC and ACC students respectively had a positive perception that pictorial quizzes could enhance their correct use of tools and equipment.

2. 33% and 62% of CC and ACC students respectively did not agree that pictorial quizzes did not enhance their confidence in workshop practice.

The results above implied that many students of both classes recognized the value of pictorial quizzes for their use of tools and equipment, and for their confidence in workshop practice. These results could be explained on the grounds that the content of the consolidating unit topics were gathered from the main points in study unit topics and experience in the practice unit exercise. This provided an opportunity for students to review their knowledge and experiences on use of tools, working techniques, etc. It is quite likely that students would answer most pictorial quizzes correctly. This in turn anchored their ideas and helped store their knowledge. In this circumstance students should be able to recall stored knowledge promptly and correctly at work, thereby enhancing their confidence as resulted from a correct recall of stored knowledge and experience.
Positive perceptions on the questions leading to planning amounted to the following four results:

1. 50% and 85% of CC and ACC students respectively had a positive perception that the questions leading to planning facilitated correct working.

2. 83% and 92% of CC and ACC students respectively had a positive perception that the questions leading to planning were quite challenging.

3. 8% and 62% of CC and ACC students respectively did not agree that the questions leading to planning were of no use and only wasted time. However, 67% and 31% respectively did agree with this statement.

4. 8% and 31% of CC and ACC students respectively did not agree that the questions leading to planning diminished their confidence, whereas 42% and 31% respectively did agree with this statement.

The results above indicated merits and demerits of the questions leading to planning. This section was provided in the practice unit programmed exercise leaflet. Students were not required to complete it (see an example in Appendix B 2). Most students of both classes perceived it as facilitating correct working and providing a challenge. This can probably be explained on the grounds that:

a) The material provided were related to the sequence of operations, use of tools, techniques of working or solving anticipated problems, etc. This would lead to increased student awareness in work.

b) The questions were presented in such a way as to make a student think before working. This feature of the questions would lend itself for challenging, as a student read the questions and followed the suggested line of thought.
The group of CC and ACC students who thought the questions leading to planning diminished their confidence were probably those who could not answer them and thus increased their uncertainty.

In relation to the above circumstances the CC and ACC students who thought completing the questions leading to planning was a waste of time and of no use were probably those who could not find the correct answers for themselves. However this opinion might be due to the questions leading to planning itself not having accompanying solutions. Thus, these students might see very little point to them. Only those students who did not agree that they were a waste of time, might find it valuable in that they were being asked a series of questions by the teacher in the workshop talk. The differences in student perception in this case may be associated with each of the student's personality or achievement.

The pictorial sequence of operations was a facilitating component given in the practice unit programmed exercise leaflet. Students in both CC and ACC classes perceived it positively as can be seen from the following summary of results.

1. 67% and 92% of CC and ACC students respectively had a positive perception that the pictorial sequence of operations facilitated correct working.

2. 50% and 69% of CC and ACC students respectively had a positive perception that if there were no pictorial sequence of operations provided their work would be more difficult.

3. 17% and 85% of CC and ACC students respectively did not agree that the pictorial sequence of operations did not enhance their knowledge of planning the sequence of operations.

The results above indicated that students of both classes realized the role of the pictorial sequence of operations in both facilitating their work and in enhancing their knowledge in planning a sequence of operations. The first aspect could probably be explained on the grounds that the descriptions and pictures provided led students to position and direct their work, tools and equipment in
each successive operation. This meant students could follow operations with only little knowledge on planning required. Thus, the pictorial sequence of operations facilitated the student work. The second aspect was probably due to students having gained experience and familiarity from both working and the pictorial sequence of operations. They had in fact practiced and repeated these tasks several times and thereby become familiar with them.

Faults and remedies guides were provided in both the 'practice' and 'exercise' programmed exercise leaflets. This was aimed at facilitating students solving their own working problems. For this component of the programmed exercise leaflets students of both CC and ACC did not have a clear positive perception as can be seen in Table 7.4, and the following summary of results.

1. 17% and 100% of CC and ACC students respectively had positive perceptions that the faults and remedies guides made them more aware of possible working errors. But 75% of CC students were not quite certain about this.

2. 33% and 46% of CC and ACC students respectively had positive perceptions that the faults and remedies guides enabled them to work on their own with less help from the teacher. But 25% and 15% respectively had opposite perceptions on this point.

3. 25% and 46% of CC and ACC students respectively did not agree that the faults and remedies guides provided were not applicable to their work. But 42% CC students did agree with this.

4. 33% and 23% of CC and ACC students respectively did not agree that the faults and remedies guides diminished their confidence. But 25% and 69% respectively did agree with this.

The results above indicated firstly that all ACC students realised the role of the faults and remedies guides as reminding them of possible working errors while most CC students did not. It might be the case that this was dependent upon the personality of individual students on the one hand and the recommendations of the teacher on
the other hand. Some students might take the information in the guides seriously right away while others just ignored it until the problems arose. The teacher might have had some influence through suggesting to students that they should take the information in the guides seriously.

For other aspects, some CC and ACC students could use and gain benefit from the guide and thereby needed less help from the teachers but for other CC and ACC students did not derive this benefit. This might be because some students did not have problems quite like the ones given in the guide. To prevent further damage on their work these students could find the teacher a useful and reliable resort. Other students might plausibly use the guide when they failed to achieve something due to a lack of skill. It is quite likely that students who failed to use the guide successfully for their problems would feel upset and consequently lose confidence.

The same level of student perceptions as the preceding one was found for the pictorial illustrations of good and poor work. 42% and 62% of CC and ACC students respectively did not agree that pictorial illustrations of good and poor work did not help them appreciate good quality work. But 25% and 31% respectively did agree with them. This result implied that many CC and ACC students realized the merit of pictorial illustrations of good and poor work. The students who did not think thus probably failed to pay much attention. Also the illustrations given were simplified isometric drawings, some students might have found it hard to distinguish good and poor work in reality. For these students more realistic drawings, real objects or photographs of samples might be required.

Planning of sequence of operations was an enrichment task given to students only in the exercise unit stage. ACC students had positive perceptions about it while CC students negative ones. The summary of student responses is as follows:

1. 8% and 62% of CC and ACC students respectively did not agree that their competence in planning a sequence of operations was dependent on workshop practice only, whereas 58% and 15% respectively did agree with this.

2. 33% and 62% of CC and ACC students respectively did not agree that a planning of sequence of operations was very time consuming, while 42% and 31% respectively did think this.
3. 25% and 69% of CC and ACC students respectively did not agree that discussing the planning of a sequence of operations with the teacher did not enhance their understanding of it, but 73% and 15% respectively did agree.

The results above contrasted quite clearly the perceptions of CC and ACC students on the factors involved in planning sequence of operations. The results implied that many ACC students had positive perceptions while many CC students negative ones. This might be due to two reasons.

a) Many CC students simply forgot to recall other knowledge and experiences gained previously from study unit topics, pictorial sequence of operations, and report writing.

b) Many CC students simply ignored all the knowledge and experience mentioned above, and thus found the requirements for planning a sequence of operations were far beyond what was provided in the study unit topics.

The next aspect concerned was the time used in planning the sequence of operations. Many CC and ACC students thought this task was very time consuming, but others did not think so. The discrepancy of perceptions between these two groups of students could be due to a number of plausible factors such as the teacher's demands, the difficulty of the task, the student's style of working, and format used. For example, some students were asked by the teacher to provide more precise descriptions and details of tools used. Some students might find this task difficult and required a lot of time. Their style of working was also affected, like the discussion with colleagues was much longer than if they would work individually. The format which students used might also be too complicated. But in some cases the teacher might make it simpler by just asking for a list of operations without much detail of tools used or accuracies required. These circumstances were varied for different students. Thus, it is probable that these factors accounted for the difference in student perceptions in relation to time used in planning a sequence of operations.

There were some CC and ACC students who did not find the
discussions with the teacher on planning a sequence of operations enhanced their understanding. This was a little puzzling. But it might possibly be due to the teacher failing to recognize some weaknesses in his students. Or the teacher might not have checked the student's plan properly and thus failed to explain useful information to students. This result if it did happen, I would rather think it was a failure of a particular teacher but not the system of discussion.

On average the perceptions of students in both classes towards grading sheets were positive. The list below is the summary of the student responses.

1. 42% and 85% of CC and ACC students respectively had a positive perception that the grading sheets provided a list of quality measurements that facilitated their understanding in planning the sequence of operations.

2. 17% and 92% of CC and ACC students respectively had the positive perception that the grading sheets provided a challenge in their work.

3. 67% and 92% of CC and ACC students respectively had the positive perception that without grading sheets they would be uncertain about the quality needed for good work.

4. 25% and 77% of CC and ACC students respectively did not agree that grading sheets were of no use and made redundant by the drawings, whereas 17% and 8% respectively did agree this.

The results above indicated that most students of both classes realized the value of grading sheets for their planning, satisfaction and work. Grading sheets facilitated the student's planning by providing both the isometric drawing and a list of measuring operations. An isometric view is the easiest drawing to interpret, so it facilitated the students' reading of the actual working drawings. The list of measuring operations were in most cases congruent with the sequence of operations. At the same time the grading sheets contained details of specifications with precise tolerances which sometime could
not be found in the working drawings. Students were set a challenge by these specified tolerances such as surface finish of 0.8 μm, or the squareness of 0.2 gap. Grading sheets could be viewed as unnecessary because the drawings (as was perceived by some students) in terms of the repetitive drawings and specifications. In this case however one could argue that this was not their main function of providing communication and precision in measuring work. Quite often it could be seen that students had problems in reading drawings, forgot to chamfer all the edges, or forgot to measure some dimension. All these points can probably be accounted for by the student perception that if it would be no grading sheet provided they would be uncertain about the quality needed in good work.

For grading activity students of both classes also had the same positive perceptions as for the grading sheets. In the traditional training system students would not be set this task. The students' reaction to this enrichment task introduced in the new training system were as follows:

1. 25% and 46% of CC and ACC students respectively did not think that this task was time consuming whereas 25% and 39% respectively thought it was.

2. 33% and 92% of CC and ACC students respectively did not think that this task was too complicated whereas 17% and 8% respectively thought it was.

3. 17% and 85% of CC and ACC students respectively did not think that their willingness to take this course was diminished as result of this additional grading task, whereas 42% of the CC students did think it was.

4. 50% and 92% of CC and ACC students respectively agreed that their working competence was greatly improved by prompt grading results. Only 8% of the CC students did not agree with this.

5. 50% and 100% of CC and ACC students respectively agreed that their competence in measuring was improved by grading activities. Only 8% of the CC students did not agree with this.
The results above indicate positive perceptions from the majority of ACC students and many CC students. This implied that they appreciated the roles and features of grading activities. These positive outcomes can be generally explained on the grounds that grading activities demand nothing but repetitive application by students of routine measuring operations during production, and with additional rules and criteria for judging grades. Practicing these activities as part of some exercises of the whole work became just other routine activities.

On the basis of achievement motivation prompt results constantly urged students to improve themselves and thus move toward self-actualization and responsibility, provided that there was no threat from the teacher. The 42% of CC students who claimed that their willingness to take this course was diminished as a result of these activities could have two reasons.

a) There was either a threat from the teacher of some kind during discussions with students about measuring and grading, or a lack of concern by the teacher.

b) Students disliked this task because it was either too complicated or too time consuming, as can be seen from the results shown above on items 1 and 2.

As the grading had to be carried out for all specifications and the discussion between each student and the teacher, this could be time consuming if the workpiece being measured was large or if the student had made may errors. In any case it would take about 10 to 15 minutes. Time spent in this activity or others could be made up by allowing students to work during breaks and in the evening.

The last component or activity in the new training system was report writing. Its main aim was to provide additional review knowledge for the students on planning sequence of operations and workshop theory. The one item on this activity revealed:

1. This was based on a 3 point scale, good = 3, fair = 2, poor = 1, and limits of specified tolerances.
33% and 92% of CC and ACC students respectively agreed that report writing enhanced their competence in planning the sequence of operations, 25% and 8% respectively did not agree with this.

The result above indicated that some CC students and almost all ACC students had a positive perception of the role of report writing in relation to planning a sequence of operations. The students who did not agree:

a) might have not worked or reviewed this task by themselves.

b) might have thought the questions on each workpiece (exercise) were not related directly to knowledge required in planning a sequence of operations.

c) might have thought rewriting the sequence of operations of the completed work did not provide any new knowledge on planning such a sequence of operations, but was just repetitive work.

To overcome these negative arguments a general meeting with all students to discuss the aims, contents of reports and other matters would need to be held to demonstrate to students how appropriate these were to their needs.

The summary of the results in this survey study could be given as:

1. ACC students on average had positive perception on all activities and components, except two components where they inclined toward the neutral position; these were the faults and remedies guides, and the pictorial illustration of good and poor work.

2. CC students on average had ten neutral perceptions inclined towards positive side. And the learning objective was perceived very positively.

Having compared the above results to student attitudes at the pre-system stage, it was found that:
1. The perceptions of both classes on workshop knowledge at the end of the workshop training course were congruent with their high ambitions at the pre-system stage.

2. The perceptions of ACC students of planning a sequence of operations were congruent with their expectations at the pre-system stage. But the perceptions on this matter for CC students appeared to be in the opposite direction to their moderate expectations in the pre-system stage.

3. The perceptions of ACC students on grading activities were congruent with their previous opinions.

After reference to the students' previous workshop experience it was found that:

- ACC students at the end of this course had positive perceptions on report writing, whereas many of them did not like this activity much in the previous course. This implies a greater satisfaction with report writing in this course than that of the previous course.

- CC students had the same moderate perceptions of report writing as they had in the previous course.

7.8.4 RESULTS ON STUDENT ATTITUDES TOWARDS THE NEW AND THE TRADITIONAL TRAINING SYSTEMS

This study was divided into two separate parts. The first part surveyed student perceptions of the comparative roles of teacher and equivalent programmed aids in the new training system. The second part was about student preferences in the activities, events and conditions in the new and the traditional training system. The first survey was undertaken as part of the previous questionnaire, while the second was conducted separately a week later. This was for two main reasons. Firstly, I did not want to load too many items in one questionnaire. Secondly, I wanted an interval in order to reduce any effect the first survey might have on the second.
I shall present in the following, first the students' perceptions of the comparative roles of the teacher and equivalent programmed aids in the new training system, and then follow with student preferences for the activities, events and conditions in the new and the traditional training systems.

a) Results on student perceptions of the comparative roles of teacher and equivalent programmed aids in the new training system

12 of 18 CC students and 13 of 19 ACC students returned the completed questionnaires. The results from student response distributions of this part of the questionnaires are given in Appendix E7 and show percentages of students choosing each of the points a 5 point agreement scale on 11 items. It was found that only item 3 had a statistically significant difference in student response distribution between CC and ACC students, at 95% confidence level, as computed with the Kolmogorov-Smirnov two-sample test.

In the new training system a number of teaching-learning methods and learning/training facilitators were provided as alternatives to teacher teaching and supervision. In the following I shall present results and discussion on student perceptions of these comparative cases.

Table 7.5 shows the average responses of both CC and ACC students on 11 cases contrasting the roles of teacher and programmed aids. It was found that for items 1 and 2 both classes had very similar perceptions close to undecided position on the agreement side. It implied that students of both classes were more likely to agree that:

a) it was easier to understand a lecture than self-studying with a programmed text.

b) it was much faster to study a programmed text themselves than to attend a lecture.

These student perceptions were quite similar to what had been found in a number of experiments discussed in chapter 4. There it was found that there were no statistically significant differences in student achievements between lecture and self-study, and that
Table 7.5 Results on student perceptions of the comparative roles of a teacher and equivalent programmed aids in the new system.

<table>
<thead>
<tr>
<th>COMPARATIVE CASES</th>
<th>Student responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>SA A UD D SD</td>
</tr>
<tr>
<td></td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1. It was easier to understand a lecture than the material in a programmed text</td>
<td>2.8 2.4</td>
</tr>
<tr>
<td>2. It was faster to study a programmed text yourself than to attend a lecture</td>
<td>2.8 2.7</td>
</tr>
<tr>
<td>3. It was more difficult to understand the teacher's demonstrations than to study the pictorial sequence of operations yourself</td>
<td>2.4* 4.0^</td>
</tr>
<tr>
<td>4. It was more interesting to observe the teacher's demonstration than to study workshop programmed exercise leaflets</td>
<td>2.3 2.0^</td>
</tr>
<tr>
<td>5. The teacher's emphasis during demonstrations was stronger than the emphasis given in programmed exercise leaflets</td>
<td>2.0 1.9</td>
</tr>
<tr>
<td>6. The teacher's demonstrations gave more confidence than self-study of the programmed workshop exercise leaflet</td>
<td>2.5 2.0^</td>
</tr>
<tr>
<td>7. Self-study of the pictorial sequence of operations was easier to follow than teacher's demonstrations</td>
<td>2.9 2.6^</td>
</tr>
<tr>
<td>8. The material covered in the teacher's demonstrations was less than that in the programmed workshop exercise leaflets</td>
<td>2.3 3.1</td>
</tr>
<tr>
<td>9. The teacher's explanations of faults and corrective measures were more understandable than self-study of the faults and remedies guides.</td>
<td>2.6 2.4</td>
</tr>
<tr>
<td>10. Referring to the faults and remedies guides was much faster than calling for the teacher's help</td>
<td>2.6 2.8</td>
</tr>
<tr>
<td>11. Having the programmed workshop exercise leaflets with you, you would be less likely to ask for the teacher's help</td>
<td>2.6 2.4</td>
</tr>
</tbody>
</table>

* p < 0.05
students spent less time on self-study than in attending lectures. A possible reason why students thought they were more likely to understand lectures than self-study, might be due to their familiarity with lectures. This could be justified on the grounds that these students had experienced lecturing methods from their early schooling but self-study with programmed texts for a fortnight. Thus, they still had a rather strong conservative attitude towards the lecture method. I would have thought, if they were to study with programmed texts or other materials individually for some long time, then they might learn better with self-study and have positive perceptions about it.

Student perceptions for item 3 were significantly different between CC and ACC students. The ACC students, on the one hand, did not agree that observing teacher's demonstrations was more difficult to understand than self-studying on pictorial sequence of operations, while the CC students, on the other seemed to agree with it. This might have been due to a particular teacher was lacking demonstrating skills, or students not paying enough attention while the teacher was demonstrating. Also students could always refer to pictorial sequence of operations at anytime. This might account for the perception of CC students in favour of self-study.

CC and ACC students had very similar positive perceptions towards the teacher's demonstration on items 4, 5 and 6. These results implied that the teacher's demonstrations were superior to the programmed workshop exercise leaflet as it:

a) was more interesting
b) more strongly stressed important points
c) enhanced the confidence to students.

These results could be explained as being due to the fact that the programmed workshop exercise leaflets were passive information sources, whereas the teacher was a lively active and thoughtful information source. He could react in a two-way communication process, unlike the programmed workshop exercise leaflets. I should like to point out that if I had used other media such as programmed tape-slides, and 8mm films then self-study would also provide all those three
merits. For example, slide pictures could give realistic colours, three-dimensional life size views of objects or even enlarged, close-up views. Students could also progress forward and refer backward at will. This argument had not been tried out in my investigation.

CC and ACC students also had very similar perceptions on item 7. Their perceptions were positive but very close to the neutral line. That means they were likely to agree that self-study of a pictorial sequence of operations was easier to follow than the teacher's demonstrations. This result was quite different from that on item 3. The distinction between understanding and following could have been made by students of both classes. I might conclude that it was not difficult to understand the teacher's demonstrations, in one respect, but in another it seemed easier to follow the pictorial sequence of operations than to follow the teacher's demonstrations. This could probably be justified from the point of view that the teacher would concentrate on his demonstrations and commentary rather than on students who were observing him. In that respect he might prefer to demonstrate and talk uninterruptedly. So that students could not follow him. Or in another respect, students themselves might have failed to follow at some points by paying much of their attentions on different points of the teacher's demonstration. This is because there were many interesting things to be observed and everything seemed to catch their attention. For example, students might observe the file being moved over a workpiece while the teacher was talking about the movement of hands, arms and legs. Thus, students just failed to follow the teacher.

In regard to the material covered in the teacher's demonstration and in programmed workshop exercise leaflets (see item 8) CC and ACC students perceived quite differently. But there was no statistically significant difference. For CC students agreed that the material covered in the teacher's demonstrations were less than in the programmed workshop exercise leaflets, whereas ACC students seemed to disagree. This different perception is probably dependent upon the different situations. It is possible that sometimes the teacher might have thought that what he was going to demonstrate or talk to students about was actually a repetition of the previous matter. Thus he omitted that part in his next workshop talk. But in the programmed workshop exercise leaflets the material was fixed in accordance with the format of organization used. That means the material was for each
type of programmed workshop exercise leaflet, (see an example of
programmed exercise leaflet in practice unit and exercise unit stages
in Appendix B2 and B4). In the situation of the ACC class, the teacher
might have valued repetitive information, so that he gave it in his
workshop talk. These are just possible arguments for different
perceptions of the two classes.

As regards the comparative roles of the teacher in exploring
faults and corrective measures and of the faults' and remedies guides,
the results shown on item 9 and 10 indicate the relative merits. CC
and ACC students had very similar perceptions on this matter. The
results indicated that:

- the teacher's explanations of faults and corrective measures
  were more understandable than self-study of the faults and
  remedies guide.

- referring to the faults and remedies guides was much faster
  than calling for the teacher's help.

These results can probably be explained from the point of
view that the information given in the guides was fixed, being that
which had been anticipated by the author. In some cases it might
not be directly relevant to some students' problems. Studying the
guide needed some interpretation, and some students might have
difficulty to digest or follow it. But the teacher as a live human
being, could identify and deal with all sorts of working problems.
However, the teacher had to deal with many students and also with
other office business, so that he was less accessible to students.
This might account for the student perception that referring to
the guide was much faster than calling for the teacher's help.

On the last item students of both classes had very similar
perceptions that if they had programmed workshop exercise leaflets
to hand, they would be less likely to ask for the teacher's help.
The result indicated that students would prefer using programmed
workshop exercise leaflets rather than asking the teacher's help.
This result could be explained as due to the limitation on the teacher's
availability to students at any-time. In addition, information
provided in the programmed workshop exercise leaflets might be
sufficient for students to follow or consult. I should reiterate that
in practice students also asked for the teacher's help especially
during their early stage of training as already discussed in chapter 6.
From all the results above both the teacher's role and the merits of programmed aids could be drawn as follows:

1. The teacher's demonstrations were more interesting to observe than self-study of pictorial sequence of operations.

2. The teacher's emphasis on important points during demonstrations was greater than the emphasis given in programmed workshop exercise leaflet.

3. The teacher's demonstrations gave more confidence than self-study with programmed workshop exercise leaflets did.

4. The teacher's explanations of faults and corrective measures were more understandable than self-study of the faults and remedies guides was.

5. Self-study with study unit programmed texts was faster than attending lectures.

6. Self-study of pictorial sequences of operations was easier to follow than the teacher's demonstrations.

7. Referring to the faults and remedies guides was much faster than calling for the teacher's help.

8. Students were less likely to call for the teacher's help if they had their programmed workshop exercise leaflets to hand.

b) Results of student preferences in the activities, events and conditions of the new and the traditional training system.

This questionnaire was administered to all CC and ACC students two days before the end of the training course. 17 of 18 CC students and 15 of 19 ACC students returned the completed questionnaires.
This questionnaire first compared the two different learning/training conditions in both the new and the traditional training systems, and secondly considered some conditions unique to the new training system. The former study will be called 'rival conditions between the new and the traditional training systems', and the later 'alternative conditions within the new training system'.

The percentages of students' response distributions on both parts of the questionnaire are given in Appendix E8. There were four occasions which student responses of both classes had statistically significant differences, as computed with the Kolmogorov-Smirnov two sample test.

I shall present in the following the summary of results and discussions first on the rival conditions between the new and the traditional training systems, and follow the alternative conditions within the new training system.

i) Results on rival conditions between the new and the traditional training systems.

There were 22 conditions in comparison between the new and the traditional training systems, covering many learning/training aspects like learning-teaching methods, workshop regulations, working styles of students, enrichment tasks and tests. The comparisons were accomplished by students choosing one of five options which had dual meaning: 1) degree of preference and 2) the training system favoured.

The summary of student response average in comparisons are given in Table 7.6(a). It can be seen that in general CC students were likely to choose less extremely than ACC students. But there was no apparent tendency indicating either CC or ACC students had particular tendencies to choose highly in favour on any topic.

Items 1 to 4 compared some features of the individualized learning adapted to the new training system with other alternative features of the traditional training system. It was found that students of both classes were clearly in favour of three features of the individualized learning (new training system). These were:

- studying workshop theory in other places rather than in the classroom.
- the sequence of topics being chosen by the students themselves rather than being given by the teacher.
Table 7.6 (a) Results of student preferences in learning/training conditions in the new and the traditional training systems.

<table>
<thead>
<tr>
<th>Traditional training system</th>
<th>Like</th>
<th>Neutral</th>
<th>Like</th>
<th>New training system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

1. Studying workshop theory in the classroom. 3.9
   Studying workshop theory in other places 4.0
2. The sequence of topics given by the teacher 3.7
   The sequence of topics chosen by the student 3.9
3. The lesson given by the teacher 2.8
   The lesson studied by the student on his own. 3.2
4. Learning objectives not given 3.7
   Learning objectives given in each lesson 4.1
5. Students must assemble prior to working in workshop 2.7
   Students not assemble prior to working in workshop 3.5
6. Student attendance checked 3.1
   Student attendance not checked 3.4
7. Working only in working hour 3.1*
   Working possible in breaks or overtime 4.6
8. Rest during working hours only with permission 3.8
   Rest during working hours possible at anytime 3.9
9. The sequence of workshop exercises given by the teacher 3.1
   The sequence of workshop exercises chosen by the student 4.1
10. Operations must follow given sequence 3.1
   Opportunity to plan the sequence of operations 4.0
11. Only descriptions given to the sequence of operation 3.1
   Pictorial illustrations accompany descriptions in the sequence of operations 4.3
12. Solutions to faults must be asked for from teachers 3.8
   Information about faults and remedies available. 4.0
13. No pictorial illustrations of good and poor work given 3.4
   Illustrations of good and poor work provided 4.1
14. Quality of produced work measured from only the given drawing 2.9
   Quality of produced work measured from both the given drawings and grading sheet 4.3
<table>
<thead>
<tr>
<th>Traditional training system</th>
<th>( \bar{x} )</th>
<th>Like</th>
<th>Neutral</th>
<th>Like</th>
<th>New training system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. No review of workshop theory prior to actual production exercises</td>
<td>3.4</td>
<td>4.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. No review questions given to report assignments</td>
<td>3.9</td>
<td>3.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. A report to be submitted every week</td>
<td>2.7</td>
<td>3.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Grades awarded only on certain exercises</td>
<td>3.1*</td>
<td>3.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Grades awarded by the teacher to finished work</td>
<td>2.8</td>
<td>4.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. No workshop theory test</td>
<td>3.6</td>
<td>4.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. No workshop practice test</td>
<td>3.4</td>
<td>3.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Teacher's demonstration of working techniques can be observed</td>
<td>2.5</td>
<td>3.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Review of workshop theory prior to actual production exercises
Review questions given to report assignments
A report to be submitted after every exercise
Grades awarded to every exercise
Grades awarded by students to finished work
Workshop theory tested
Workshop practice tested
Study working techniques only from programmed workshop exercise leaflets.

--- CC  
--- ACC  
* \( p < 0.05 \)  
** \( p < 0.01 \)
learning objectives being stated for each lesson rather than not being given at all.

There was a slight difference in preference between the two classes in respect of learning methods. While CC students had a slight tendency in favour of the lecturing method, ACC students favoured the self-study method. However, their preferences were in the region of the neutral positions, thus implying that both classes preferred equally both the lecture and the self-study methods.

Having referred to student attitudes at the end of study unit stage (section 7.8.2(b)), it was found that students of both classes were confirmed in their attitudes in favour of choosing their own sequence of programmed texts. There students also preferred to choose their own study place.

The reasons why students preferred the lecture method as equally as self-study have been discussed in section 7.8.3 and also in Chapter 4.

Students preferred the learning objectives to be given rather than omitted. This aspect is already discussed in section 7.8.3.

Items 5 to 8 concerned workshop regulations and flexibilities. The results in Table 7.6(a) indicated that:

- CC students had their preferences inclined toward class assembly prior working, whereas ACC students had their preferences inclined toward no class assembly. But there was no statistically significant difference.

- both CC and ACC students had similar preferences inclined toward no attendance check.

- while CC students had a slight preference towards flexible working time, ACC students strongly preferred flexible working time. Their preferences were significantly different.

- both CC and ACC students had very similar preferences for flexible working conditions by which they could take a rest at anytime during working.
From the results above, it implied that students of both classes preferred the working conditions provided in the new training system rather than those in the traditional one. This could be explained as being due to conditions in the new training system being more relaxing and more flexible than those in the traditional system. This kind of working atmosphere posed no threat to students unlike the traditional system in which students might find constant threats from the teacher who enforced strict workshop rules and regulations.

For student preference on item 9, the results indicated considerable differences between preferences of the two classes. However, there was no statistically significant difference. While CC students had a slight preference for choosing the sequence of workshop exercises themselves; ACC students had strong preference for it. The ACC students' preference in this matter was congruent with their preference for choosing their own sequence of study unit topics. This implied that ACC students were more self-reliant than CC students.

Item 22 concerned methods of obtaining information on working techniques. The results indicated quite a range of preferences, but no statistically significant difference. CC students had strong preference to observing teacher's demonstrations on working techniques, whereas ACC students had a slight preference for self-study with programmed texts. This result could be interpreted as showing that both groups of students preferred each method equally, for a number of reasons were already discussed in the previous section.

Items 10, 15 and 16 concerned enrichment tasks. The results indicated that:

-CC students had a slight tendency toward preferring an opportunity to plan their own sequence of operations, whereas ACC students had clear preference for this.

-CC students had a strong tendency towards preferring a review of workshop theory prior to actual workshop production exercises, whereas ACC students had a clear preference for this.

both CC and ACC students had very similar preferences for review questions given to report assignments.
The results implied that students of both classes were in favour of the task enrichments given in the new training system rather than not having them at all as in the traditional training system. For task enrichment in planning, it was found that the preference of CC students at the end of the training course was congruent with their expectation on this matter found at the pre-system stage, whereas for ACC students a positive shift was found. That means they liked this enrichment task more than they had expected.

In relation to the convenience of submitting reports, the result on item 17 indicated that CC students had a preference towards submitting a report every week, whereas ACC students toward submitting it after every exercise. This result can be interpreted as showing that on average both classes liked both arrangements equally.

Items 11 to 14 concerned learning/training aids provided in the new training system. The results given in Table 4(a) on these items indicate that:

- CC students had a slight tendency toward preferring a pictorial sequence of operations to only having descriptions of the sequence of operations. Meanwhile ACC students had a very clear preference for a pictorial sequence.

- Both CC and ACC students had the same preference for having the faults and remedies guide to hand rather than asking the teacher for solutions to faults.

- CC students had a strong preference for illustrations of good and poor work being given rather than omitted. Meanwhile ACC students had a very clear preference for illustrations.

- CC students had a slight preference for measuring the quality of work from the given drawings rather than from grading sheets accompanying the drawings. Meanwhile ACC students had a very strong preference for the grading sheets. There was a statistically significant difference between them on this issue.

The results on whether a pictorial sequence of operations should accompany normal descriptions of sequence of operations or not showed that the CC students favoured both conditions equally. This can
probably be explained as the CC students did not mind whether there was a pictorial sequence of operations given or not, as they could still be able to work well even without it. Yet the ACC students would probably think of other benefits they gained from having the pictorial sequence of operations as already discussed in the previous section. The conclusion in this case would be that both classes realized the benefits of having the pictorial sequence of operations accompanying the normal descriptions of sequence of operations.

As regards grading sheets being given or not with the drawings, CC students favoured both conditions equally. However, there were signs indicating that CC students had a tendency to prefer no grading sheets being given with the drawings. This could possibly be due to some CC students not wanting to spend more time in measuring every detail of the work as specified on the grading sheets. There was the evidence of this in the previous section. However, ACC students, who greatly preferred having the grading sheets might probably value their other merits, already discussed in the previous section. The conclusion could be drawn in this case that the grading sheets were useful and would be more highly favoured if there were less items of quality measurement specified on them.

Items 18 and 19 concerned the grading of finished work. The results shown in Table 7.6 (a) indicated that:

- CC students had a slight tendency towards preferring grades being awarded for every exercise rather than only some exercises. ACC students clearly preferred this.

- CC students had a slight tendency to prefer the teacher awarded grades to finished work rather than students awarded grades to finished work. Meanwhile ACC students clearly favoured the latter.

The results above indicated consistent standing of ACC students in favour of self-grading of finished work. Their attitudes at this stage were congruent with those found at the pre-system stage. The perceptions on this matter of ACC students are already discussed in the previous section. Whereas the standings of CC students on this matter were slightly inconsistent at this stage with respect of their preferences. Referring to CC students' attitudes at the pre-
system stage on this matter, it was found that their attitudes at this stage were not as strong as those found in the pre-system stage. The evidence on their preferences between teacher grading and student grading of finished work shown above implied the lack of interest in self-grading. Referring to the CC students' perceptions on this matter in the previous section, it was found that the willingness to work of some CC students' was diminished as a result of self-grading. This can probably be accounted for a slight shift of CC students toward teacher grading. There were conflicting perceptions of CC students as can be seen in items 34 to 36 in Appendix E6. There, many CC students (50%) agreed that their competence in measuring work was greatly improved due to grading activities; and 33% of CC students did not agree that they could hardly complete the grading of their finished work as the rules for grading were too complicated, against 17% who agreed with this statement. These results seemed to suggest that there might be other factors involved in positive gains and benefits from self-grading and diminishing willingness to work. It might be that handling skills of the teacher in charge or some kind of threats were involved. All in all, I might conclude, based on the ACC students' preferences, that gradings awarded to every exercise were more preferable to gradings awarded only to some exercises.

Items 20 and 21 concerned testing on workshop theory and workshop practice. The results shown in Table 7.6 (a) indicated that:

- both CC and ACC students preferred having workshop theory tested occasionally to not having any at all.

- both CC and ACC students preferred having workshop practice tested occasionally to not having any at all.

The results above implied that both classes were enthusiastic to know occasionally their positions in both workshop knowledge and workshop practice. These requirements could be arranged systematically at some stages of the new training system.

From all the results found in this part of the questionnaire, I conclude that the conditions, activities or events in the new training system were more favoured than the alternatives in the traditional training system. As both CC and ACC students had
experienced both systems, it gave a strong body of evidence to recognize the new training system as more appropriate than the traditional one. The following are the activities and conditions which both classes were more favourable to in the new training system than the traditional one:

1. Studying workshop theory in places other than the classrooms.

2. The sequence of topics being chosen by the students themselves.

3. Learning objectives being given in every lesson.

4. A flexible working atmosphere, i.e., breaks allowed during working.

5. Information on faults and remedies being available.

6. A review of workshop theory prior to the actual production exercises.

7. Review questions being given to report assignments.

8. Occasional workshop theory tests.


ii) Results on alternative conditions within the new training system

This part of the study is continued from the previous one. There were six pairs of comparable learning conditions, actual and alternative, within the new training system. The actual conditions in this study were those featured in study unit programmed texts and workshop practice, whereas the alternative conditions were either proposed (item 23) or simulated during the investigation. The results of student response average for both CC and ACC students on their preferences are given in Table 7.6(b).
<table>
<thead>
<tr>
<th>Actual conditions</th>
<th>Student response average</th>
<th>Alternative conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Like 1 2 3 4 5</td>
<td>Work with actual production exercises right away.</td>
</tr>
<tr>
<td>23. Work with simple examples prior actual production exercises.</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>24. A target time is given for each production exercise.</td>
<td>3.0</td>
<td>No target time given.</td>
</tr>
<tr>
<td>25. A pre-test given in every lesson.</td>
<td>2.3</td>
<td>No pre-test given.</td>
</tr>
<tr>
<td>26. A post-test given in every lesson.</td>
<td>1.7</td>
<td>No post-test given.</td>
</tr>
<tr>
<td>27. Exercises given in every lesson.</td>
<td>1.8</td>
<td>No exercise given in any lesson.</td>
</tr>
<tr>
<td>28. Solutions to exercises given.</td>
<td>1.9</td>
<td>No solutions to exercises given in any lesson.</td>
</tr>
</tbody>
</table>

Items 23 and 24 concerned the conditions in workshop practice.

The results indicated that:

- ACC students had a clear preference for working with simple examples prior to actual production exercises, rather than working on actual production exercises right away. Whereas, CC students had only a slight preference for this.
ACC students had a clear preference for a target time to be given for each production exercise than for none to be given at all. However, CC student regarded both conditions absolutely equally.

The results above indicated that working with simple examples prior to actual production exercises were more favourable than working with actual production exercises right away. This could be explained from the evidences found during the first stage of the students' practice of skills in sawing and chiselling, and also the average number of acceptable pieces of work during both the practice unit stage and the exercise unit stage (see diagram 6.2). Students in the early stages of their practice made many errors and gradually improved until in the practice unit stage they could produce work on their own. However, they still made a number of errors on their own work in the practice unit stage as well as the exercise unit stage. Any error made on the actual production exercises (a small vice) would have a considerable impact at the final assembly stage. Whereas any errors made on example work (U-shaped work) had no impact to the actual exercises at all. ACC students probably realized this point as judged from their skills development. Thus, they preferred working with examples prior to the actual production exercises. The CC students, who had one day workshop practice less each week than the ACC students, had only a slight preference for working with examples prior to the actual production exercises. This is probably due to the shortage of their working hours.

Items 25 to 28 concerned activities or components of learning given in the study programmed texts. The results from Table 7.6(b) indicated very similar preferences between CC and ACC students on all conditions favouring the actual rather than the alternatives. These results give strong evidence in support of the merit of components provided in the study unit programmed texts. These components were for each lesson:

- a pre-test
- a post-test
- exercises,
- solutions.
With regard to the results on the survey study at the end of the study unit stage and the results shown above, I could conclude that there were consistent results, in respect of CC and ACC students experiences, supporting pre-test, post-test, exercises, and solutions to exercises as desirable components in study unit programmed texts.

Arising from the discussion and conclusions in each part of this questionnaire, the following observations in respect of training stages, activities, and conditions given in the new training system can be made:

1. Both CC and ACC students preferred the training stages as arranged in the new training system.

2. On the average both CC and ACC students accepted the principles of self-learning and self-training, but there were some students who expressed dislike for it. The areas of problem were on self-study on study unit programmed texts and programmed exercise leaflet, and self-selection of sequence of study unit topics and workshop exercises.

3. On the average CC and ACC students preferred the task enrichments given in the new training system, even though some students did not like it. The areas of problem were on self-grading of finished work and the frequency of grading.

4. CC and ACC students on the average preferred having the freedom to take a rest at anytime during working, and tests on workshop theory and workshop practice administered to them. Some students indicated preferences for the usual compulsory daily assembly that existed in the conventional situation where daily attendance is checked. Some students were also in favour of being given a target time in which to complete their workshop exercises. Some others showed preferences for submitting a report after every workshop exercise rather than once in every week.

5. Both CC and ACC students favoured the presentation of study programmed unit texts in a well structured format as I have designed.
6. On the whole CC and ACC students preferred the structure given in the programmed workshop exercise leaflet.

7.8.5 RESULTS ON TEACHER INVOLVEMENT IN THE NEW AND THE TRADITIONAL TRAINING SYSTEMS

Another aspect to validate the new training system is by means of comparing the degree of teacher involvement in student activities in the new and the traditional training systems. The comparison was accomplished by the students judging the degree of teacher involvement in a number of their main activities on a 4 point scale: high, fair, low and none. Activities being compared were the same or at least equivalent. The study was divided into two parts: the degree of teacher involvement in the students' activities in the new training system, and the degree of teacher involvement in the students' activities in the traditional training system. Both parts were conducted separately by using two different questionnaires. The former was given to all CC and ACC students, and the latter to a sample of 40 of the 100 previous semester students who were still working in the workshop in the second semester. These surveys were carried out on 15th January, 1981, for a sample of the previous semester students and five days later for all CC and ACC students.

I will present in the following results and discussion on the degree of teacher involvement in the students' activities in the new training system, then the degree of teacher involvement in the students' activities in the traditional training system, and finally a comparative summary of results found in both system.

a) Results of the degree of teacher involvement in student activities in the new training system

16 out of 18 CC students and 18 out of 19 ACC students returned the completed questionnaires. The results of student response distribution of this questionnaire are given in Appendix E9. It was found that there were no statistically significant differences between responses of the two classes.

Student activities in this survey questionnaire can be divided into four parts in accordance with the four successive training stages of the new training system. The results of response average of both
classes of this questionnaire are given in Table 7.7.

In order to differentiate the degree of teacher involvement in each training stage, I will present the results and the discussions in accordance with the training stages.

1) The degree of teacher's involvement in the study unit stage

There were 7 main student activities in the study unit stage which were judged by CC and ACC students. These activities were in fact features of individualized learning as adapted into the new training system.

The results on student response average part A (study unit stage), Table 7.7, show that both CC and ACC students had very similar judgements as to the degree of teacher involvement over all activities. It was found that six student activities had a low level of teacher involvement, in item 7 the degree of teacher involvement was almost none. These consistent results implied that the teacher involved very little in student activities in the study unit stage.

These results could be explained as students had managed their studies themselves and the teacher acted merely as a consultant or facilitator. For example, the teacher gave his advice as to selection of topics and gave students the required study programmed texts and learning aids.

As there were some topics which the author organized students for a number of experiments, it was inevitable in this circumstance that the author would be involved in student activities. His involvement included, for example, allocating students to classrooms, organizing the dates for experiments and tests, giving some lectures or controlling classes during experiments. If individualized learning was fully implemented without interferences from any experiments; I would expect the degree of teacher involvement on those activities would approach none at all.

ii) The degree of teacher involvement in the practice unit stage

In the practice unit stage students practiced their first workshop skills by working on the U-shaped workpieces. Students were given a work stock and a programmed workshop exercise leaflet for each
Table 7.7 Results of student response average on the degree of teacher's involvement in student activities in the new training system.

<table>
<thead>
<tr>
<th>STUDENT ACTIVITIES</th>
<th>Class</th>
<th>( \bar{x} )</th>
<th>Degrees of teachers' involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>High (1)</td>
<td>Fair (2)</td>
</tr>
<tr>
<td>A. Study Unit stage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Choosing study unit topics.</td>
<td>a</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>2. Studying study unit topics.</td>
<td>a</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>3. Completing exercises in study unit topics.</td>
<td>a</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>4. Checking solutions to exercises in study unit topics.</td>
<td>a</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>5. Assessing achievement on the post-test of study unit topics.</td>
<td>a</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td>6. Arranging timetable for studying study unit topics.</td>
<td>a</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td>7. Allocating study places.</td>
<td>a</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>3.4</td>
<td></td>
</tr>
</tbody>
</table>

--- CC = a
--- ACC = b

cont'd ....
### Degrees of teachers' involvement

<table>
<thead>
<tr>
<th>Student Activities</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B. Practice unit stage (U-shape work)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Choosing practice unit exercises</td>
<td>a 2.4</td>
<td>b 2.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Studying drawings and plans.</td>
<td>a 3.4</td>
<td>b 2.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Following the given sequence of operations.</td>
<td>a 1.9</td>
<td>b 2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Producing workpieces</td>
<td>a 2.4</td>
<td>b 2.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Checking faults and errors in the workpieces during operations.</td>
<td>a 2.3</td>
<td>b 2.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Correcting faults and errors on the workpieces during operations.</td>
<td>a 2.3</td>
<td>b 2.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Checking/measuring the quality of the finished workpiece.</td>
<td>a 1.7</td>
<td>b 1.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Grading the quality of the finished work.</td>
<td>a 1.7</td>
<td>b 2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Checking and approving the quality of the finished work.</td>
<td>a 1.8</td>
<td>b 2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Arranging working timetable</td>
<td>a 2.6</td>
<td>b 2.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

CC = a

ACC = b

cont'd....
### Table 7.7 (cont'd)

<table>
<thead>
<tr>
<th>Student activities</th>
<th>Degrees of teachers' involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class</td>
</tr>
<tr>
<td>C. Consolidation Unit Stage</td>
<td></td>
</tr>
<tr>
<td>1. Choosing consolidating unit topics.</td>
<td>a 2.7</td>
</tr>
<tr>
<td></td>
<td>b 3.1</td>
</tr>
<tr>
<td>2. Arranging study timetable.</td>
<td>a 3.1</td>
</tr>
<tr>
<td></td>
<td>b 3.3</td>
</tr>
<tr>
<td>3. Allocating study places.</td>
<td>a 3.6</td>
</tr>
<tr>
<td></td>
<td>b 3.5</td>
</tr>
<tr>
<td>4. Studying consolidating unit topics.</td>
<td>a 3.4</td>
</tr>
<tr>
<td></td>
<td>b 3.2</td>
</tr>
<tr>
<td>5. Assessing the achievement on each</td>
<td>a 2.9</td>
</tr>
<tr>
<td>consolidating unit topic.</td>
<td>b 2.6</td>
</tr>
</tbody>
</table>

--- CC = a

--- ACC = b

cont'd ....
<table>
<thead>
<tr>
<th>Student activities</th>
<th>Degrees of teachers' involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class</td>
</tr>
<tr>
<td><strong>D Exercise Unit Stage</strong> (A small vice)</td>
<td></td>
</tr>
<tr>
<td>1. Choosing exercises.</td>
<td>a 2.8</td>
</tr>
<tr>
<td></td>
<td>b 2.6</td>
</tr>
<tr>
<td>2. Arranging working timetable.</td>
<td>a 3.2</td>
</tr>
<tr>
<td></td>
<td>b 2.9</td>
</tr>
<tr>
<td>3. Studying the drawings &amp; work.</td>
<td>a 3.1</td>
</tr>
<tr>
<td></td>
<td>b 3.0</td>
</tr>
<tr>
<td>4. Planning the sequence of operations.</td>
<td>a 3.1</td>
</tr>
<tr>
<td></td>
<td>b 2.5</td>
</tr>
<tr>
<td>5. Checking the plan of the sequence of operations.</td>
<td>a 2.9</td>
</tr>
<tr>
<td></td>
<td>b 1.9</td>
</tr>
<tr>
<td>6. Producing workpieces.</td>
<td>a 2.3</td>
</tr>
<tr>
<td></td>
<td>b 2.8</td>
</tr>
<tr>
<td>7. Checking faults &amp; errors in workpieces during operations.</td>
<td>a 2.3</td>
</tr>
<tr>
<td></td>
<td>b 2.5</td>
</tr>
<tr>
<td>8. Correcting faults &amp; errors in workpieces during operations.</td>
<td>a 2.3</td>
</tr>
<tr>
<td></td>
<td>b 2.5</td>
</tr>
<tr>
<td>9. Checking/measuring the quality of the finished workpieces.</td>
<td>a 2.5</td>
</tr>
<tr>
<td></td>
<td>b 2.5</td>
</tr>
<tr>
<td>10. Grading the quality of the finished workpieces.</td>
<td>a 2.0</td>
</tr>
<tr>
<td></td>
<td>b 2.6</td>
</tr>
<tr>
<td>11. Checking &amp; approving the quality of the finished workpieces.</td>
<td>a 1.8</td>
</tr>
<tr>
<td></td>
<td>b 2.2</td>
</tr>
</tbody>
</table>

--- CC = a

--- ACC = b
exercise. Students worked on their own and graded their finished work. Finally they discussed the grades of each finished work with the teacher.

From all the procedures in the practice unit stage, there were ten main student activities. The response average of the degree of teacher involvement in student activities in this stage are given in part B, Table 7.7.

From the results in Table 7.7, it was found that both CC and ACC students judged the degree of teacher involvement similarly in all activities. The degree of teacher involvement was at the 'moderate' (fair) level for items 1 and 3 to 9, whereas for items 2 and 10 it was at the low level.

The degree of teacher involvement in item 2 could be used as the basis for reference on other activities. In reality there was no workshop talk or any formal discussion of plans and drawings of the U-shaped exercises. Students studied the drawing in the pictorial sequence of operations themselves. If the teacher was involved, it was in giving some clarification about quality specifications on the drawing. But his involvement was very rare indeed. Thus, this low level, according to student judgement, would in fact be practically zero. The same level of student judgement should also have resulted for item 10, since in reality students were free to come and work in the workshop at anytime. That meant there was no teacher involvement in this particular activity. It might be in the matter of interpretation that the teacher did become involved in specifying the target working time for students in every exercise. This probably accounts for a low level of teacher involvement according to the students' judgement. And this would be true also for the teacher involvement in the students choosing their practice exercises.

The teacher involved in this activity in terms of recording students work, time and giving them programmed workshop exercise leaflets and work stocks.

For other activities the students judged teacher involvement as moderate. In reality the teacher was involved with students only during their practice when he carried out his routine supervision. In some occasions the teacher was involved in checking students mistakes on workpieces and giving his advice on the correction of those faults. Usually the teacher would observe the students' order of tools and equipment on the bench, and the cleanliness of working areas. Thus,
it was quite acceptable for the students' to make a judgement of a moderate level of activities during their production.

The students' judgement of teacher involvements in grading and approving the quality of finished work (items 8 and 9) were lower than in the reality. This is because the results obtained on items 8 and 9 were based on each individual student's perceptions. In fact, the teacher had spent a lot of time in measuring and grading every student's work. And also he discussed the results with every individual student. The approximate time the teacher spent on these two activities was about 10 to 15 minutes. For all 18 or 20 students the teacher had thus spent about 3 to 3½ hours for every exercise. However, I would rather leave no adjustment on this matter and base the obtained results in terms of the students' judgement.

iii) The degree of teacher involvement in the consolidating unit stage

There were five main student activities in the consolidating unit stage. The results of student response average are given in part C, Table 7.7. It was found that both CC and ACC students had very similar judgements as to the degree of teacher involvement in all activities. The results show that the degree of teacher involvement for all activities was low and on item 3 it approached none at all.

I should like to point out some inaccuracies in student judgements on items 3 and 4. In reality the teacher was not involved at all in allocating study places or in studying consolidating unit topics. Everything was dependent on the students themselves. That means there was no teacher involvement in items 3 and 4 at all.

For items 1 and 5, the results were acceptable. Because the teacher was involved in providing learning materials for students and observing their correct response rates.

I would conclude that the degree of teacher involvement in this stage was very low indeed.

iv) The degree of teacher involvement in the exercise unit stage

Student activities in the exercise unit stage were the same
as those in the practice unit stage. And there was one more additional activity on item 4: planning the sequence of operations. The result of student response average on part D, Table 7.7, indicated that both CC and ACC students had similar judgements on the degree of teacher involvement for most of the items. There was quite a difference between their judgements on item 5, but there was no statistically significant difference, as computed with the Kolmogorov-Smirnov two sample test.

I should like to compare for the change of levels of the degree of teacher involvement in student activities between the practice unit stage and the exercise unit stage.

Having compared the scales of response average for the degree of teacher involvements in student activities between the practice unit stage and the exercise unit stage, based on the judgements of both CC and ACC students, the reduction of the degree of teacher involvement was found on 8 student activities. They were activities in the following: (N.B. the number represents the range of the scale: 1 = high, 2 = fair, 3 = low, 4 = none.

<table>
<thead>
<tr>
<th>From to</th>
<th>From practice unit</th>
<th>To exercise unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CC</td>
<td>ACC</td>
</tr>
<tr>
<td>1. arranging timetable</td>
<td>2.6</td>
<td>2.8</td>
</tr>
<tr>
<td>2. choosing exercises</td>
<td>2.4</td>
<td>2.4</td>
</tr>
<tr>
<td>3. producing work</td>
<td>2.4</td>
<td>2.2</td>
</tr>
<tr>
<td>4. checking errors in work</td>
<td>2.3</td>
<td>2.1</td>
</tr>
<tr>
<td>5. correcting errors in work</td>
<td>2.3</td>
<td>2.2</td>
</tr>
<tr>
<td>6. measuring quality of work</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>7. grading finished work</td>
<td>1.7</td>
<td>2.3</td>
</tr>
<tr>
<td>8. approving finished work</td>
<td>1.8</td>
<td>2.0</td>
</tr>
</tbody>
</table>

The activity which was approximately unchanged was the studying drawings and work. The planning of sequence of operations and checking the plan of sequence of operations will be discussed later.

The comparisons of the scales of response averages provides evidence of the reduction of the degree of teacher involvement in student activities. Even though, the values of scale differences were very small, both consistent results of CC and ACC students, and the number of activities involved provide an important indication of the
reduction of teacher involvements in the exercise unit stage. In this case, 8 out of 10 activities were found where teacher involvement had been reduced. These results were congruent with the purpose of the system design, discussed in chapter 3. Despite the small reduction of the degree of teacher involvement I would conclude that the degree of teacher involvement in 8 out of 10 student activities was reduced from the practice unit stage to the exercise unit stage.

The activity newly introduced into the exercise unit stage was on planning the sequence of operations. This shall be viewed together with a modified activity on checking the plan of sequence of operations. This activity was a discussion between individual students and the teacher about their plans.

Based on students' judgement on the planning of the sequence of operations and on the checking the plan of the sequence of operations (see items 4 and 5, part D, Table 7.7), it was found that teacher involvement in the planning activity was lower than in checking the plans of sequence of operations. This could be explained as students had to plan their sequence of operations themselves. They could do it individually or co-operatively with friends. The teacher would be involved only when students asked. For a higher degree of teacher involvement in checking the plan of sequence of operations, this could be explained as both the teacher and individual students had to discuss the proposed plan together.

Having referred to the degree of teacher involvement in checking students' plans with that of checking and approving the quality of finished work, it was found that the former was lower than the latter. This means that the degree of teacher involvement in checking the students' plan of sequence of operations was lower than that in checking and approving the quality of the finished work. This result, could be explained from the point of view that: reading the single page of sequence of operations and discussing 8 to 10 steps were less time consuming than both the teacher and a student measuring, grading, and discussing 15 check points on a work piece.

I would conclude at this stage that the degree of teacher involvement in checking the students' plans was lower than that in checking and approving the students' finished work.
b) Results of the degree of teacher involvement in student activities in the traditional training system

27 out of 100 previous semester students returned the completed questionnaires. This number of returned questionnaires was low. However, all students in this sample had experienced the same traditional system as other first year students. All first year skilled worker students operate in this workshop under the same working conditions and using the same workshop exercises and facilities. So that, the results obtained should not differ much from the total population of the first year skilled worker students.

The questionnaire used in this survey of teacher involvement in student activities was divided into two parts: one the U-shaped exercises and the other the small vice exercises. The contents of both parts of this questionnaire were almost identical to those used in the practice unit stage and the exercise unit stage, discussed earlier. The results of the student response distribution for both parts of the questionnaire are given in Appendix E10.

There were 8 main student activities in both parts of the workshop exercises, i.e. the U-shaped exercises and the small vice exercises. The results of the student response average indicating the degree of teacher involvement in all student activities of both parts of the workshop exercises are given in Table 7.8.

From the results of both sets of the exercises, it was found that the degree of teacher involvement in all 8 pairs of student activities were almost identical. Only a small variation was found in the majority of activities and these could be regarded as negligible. But a difference in the degree of teacher involvement in item 3 could be regarded as noticeable. It was found that there was a small reduction in the degree of teacher involvement from the U-shaped work exercises to the small vice exercises, of 0.3 on the 5 point scale. This could be explained from the grounds that students had gained experience and familiarity in a number of practices on the given workshop exercises.

Where there was no reduction or increase by more than 0.3 on the 5 point scale in the degree of teacher involvement, it can imply that the working conditions and teacher involvement in these activities were the same over the entire course of the training.
Table 7.8 Results of the response average in the degree of teacher's involvement in student activities in the traditional training system.

<table>
<thead>
<tr>
<th>Student activities</th>
<th>Degrees of teachers' involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\bar{x}$</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>A. U-shaped Activities</td>
<td></td>
</tr>
<tr>
<td>1. Choosing exercises.</td>
<td>1.7</td>
</tr>
<tr>
<td>2. Studying the drawing.</td>
<td>2.4</td>
</tr>
<tr>
<td>3. Following the given sequence of operations.</td>
<td>2.5</td>
</tr>
<tr>
<td>4. Producing workpieces.</td>
<td>2.2</td>
</tr>
<tr>
<td>5. Checking faults &amp; errors on workpieces.</td>
<td>2.3</td>
</tr>
<tr>
<td>6. Correcting faults &amp; errors on workpieces.</td>
<td>2.3</td>
</tr>
<tr>
<td>7. Checking &amp; measuring the quality of finished work.</td>
<td>1.7</td>
</tr>
<tr>
<td>8. Checking &amp; approving the quality of finished work.</td>
<td>1.9</td>
</tr>
</tbody>
</table>

cont'd ......
Table 7.8 (cont'd)

<table>
<thead>
<tr>
<th>Student activities</th>
<th>Degrees of teachers' involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\bar{x}$</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td><strong>B. The small vice exercises</strong></td>
<td></td>
</tr>
<tr>
<td>1. Choosing exercises of the small vice.</td>
<td>1.6</td>
</tr>
<tr>
<td>2. Studying the drawings.</td>
<td>2.5</td>
</tr>
<tr>
<td>3. Following the given sequence of operations.</td>
<td>2.2</td>
</tr>
<tr>
<td>4. Producing workpieces.</td>
<td>2.2</td>
</tr>
<tr>
<td>5. Checking faults &amp; errors on workpieces during operations.</td>
<td>2.4</td>
</tr>
<tr>
<td>6. Correcting faults &amp; errors on workpieces during operations.</td>
<td>2.4</td>
</tr>
<tr>
<td>7. Checking &amp; measuring the quality of finished work.</td>
<td>1.7</td>
</tr>
<tr>
<td>8. Checking &amp; approving the quality of finished work.</td>
<td>1.8</td>
</tr>
</tbody>
</table>
Having considered every student activity, it was found that there were three activities where the degree of teacher involvement was slightly above the moderate (fair) level. These activities were:

1. Choosing exercises.
2. Checking and measuring the quality of finished work.
3. Checking and approving the quality of finished work.

As regards choosing exercises, this could be explained from the point of view that each time the teacher had to direct and give students particular work to do. There were many working techniques involved which only the teacher knew which part should be produced first and to what accuracies. Therefore, the teacher had to be involved every time in directing and giving work to students.

The checking and measuring the quality of finished work would be combined together with checking and approving the quality of finished work. This was due to the two activities in the traditional training system were meant the same, which were unlike the new training system. The degree of teacher involvement in this activity was slightly above the moderate level. This could be explained from the point of view that there were some slight changes in techniques and the sequence of operations for some workpieces. These alternations were made by the teacher and there were no information documents given to students. The teacher would inform students of these in his workshop talks. When it came the time for measuring and approving the produced work, the teacher then decided it for students. Even though there was no grading awarded for student work in most cases, the teacher was still involved in the case where there were differences from what was given in the drawings.

For the rest of the activities, i.e. from items 2 to 6, the degree of teacher involvement were about equal midway between moderate and low. This could probably be explained on the grounds that teacher had to give his workshop talk to all students prior to working for some exercises, this included explaining details of the drawings and steps in producing work. During student working the teacher had to supervise students and give advice and assistance from time to time.
c) Comparative study of the degree of teacher involvement in student activities in the new and traditional training system

Now I would like to make a comparative study of the degree of teacher involvement in student activities between the new and the traditional training system.

First of all I should like to point out the reasons for uncomparable situation in relation to this survey study. Firstly, it can be seen that student activities over the entire system for the new and the traditional training system were not the same.

Secondly, the studies were based on different body of students, i.e. CC and ACC student in the new training system versus the sample of some previous semester first year students in the traditional training system.

Thirdly, the scale used on students' judgements had no specific criterion, i.e. there were no specific limits for 'high', 'fair', 'low', etc.

The comparative study in this circumstance would, therefore, be based upon highlights of important features in respect of the degree of teacher involvement of both training systems.

The comparative cases would be as follows:

<table>
<thead>
<tr>
<th>New training system</th>
<th>Traditional training system</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. For the study unit stage, the degree of teacher involvement in student activities were of low level and some activities approached zero.</td>
<td>There was no information available in terms of the degree of teacher involvement in lectures and workshop talks given to students.</td>
</tr>
</tbody>
</table>

Cont'd ....
For the consolidating unit stage, a number of review topics on workshop theory and workshop experiences were given to students. The degree of teacher involvement in student activities in this stage was found to be at a low level, and for some activities it approached zero.

For the practice unit stage and exercise unit stage, students had some enrichment tasks in addition to normal production tasks. These were the planning of sequence of operations, and self-grading. It was found that the degree of teacher involvement in student activities was at a low level. The degree of teacher involvement in student activities from the practice unit stage to the exercise unit stage was reduced slightly for 8 out of 10 activities.

<table>
<thead>
<tr>
<th>New training system</th>
<th>Traditional training system</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. For the consolidating unit stage, a number of review topics on workshop theory and workshop experiences were given to students. The degree of teacher involvement in student activities in this stage was found to be at a low level, and for some activities it approached zero.</td>
<td>There was no review on workshop theory nor workshop experience given to students prior to actual production exercises.</td>
</tr>
<tr>
<td>3. For the practice unit stage and exercise unit stage, students had some enrichment tasks in addition to normal production tasks. These were the planning of sequence of operations, and self-grading. It was found that the degree of teacher involvement in student activities was at a low level. The degree of teacher involvement in student activities from the practice unit stage to the exercise unit stage was reduced slightly for 8 out of 10 activities.</td>
<td>The degree of teacher involvement in student activities in the U-shaped exercise and the production of a small vice (equivalent to the practice unit stage and exercise unit stage respectively) were identical. That means there were no reduction in the degree of teacher involvement in student activities from the U-shaped work to the small vice work. The degree of teacher involvement were found to be slightly above the 'fair' level, and in some activities at the 'low' level.</td>
</tr>
</tbody>
</table>
Since there was no common ground between both training systems, as described earlier; therefore there will be no conclusion drawn in this comparative study.

7.9 SUMMARY OF FINDINGS

I will present in the following the summary of some important findings of my survey studies as discussed in this chapter.

There were seven survey studies carried out from the beginning to the end of the training course. All studies were conducted with all CC and ACC students and one study with a sample of the previous semester of the first year skilled worker students.

In the survey study into the students' previous workshop experiences, it was found that there were some lack of communication from the teacher to students on learning aims and grading. Students themselves thought they knew their own areas of strength and weakness in training. They enjoyed their work and preferred co-operative and competitive working. Students did not like report writing much. It was also found that there was some flexibility about overtime working.

For the students' expectations of the new workshop training course, it was found that many students of both CC and ACC classes had high ambitions for their final grades in this course, and workshop knowledge. Their ambitions were moderate on workshop activities. Many students seemed to be less independent and self-reliant.

In this survey of students' attitudes towards the new training system at the pre-system stage, it was found that almost all students of both classes had positive attitudes towards course arrangement. Such as a project work, training stage. Many students had positive attitudes towards choosing their own sequence of topics and self-studying. About 50% of students had positive attitudes to self-pacing, but other expressed worry about these.

At the end of the study unit stage, there was a study into both student attitudes toward the features of the individualized learning, and student perceptions of the structure of the study unit programmed texts. It was found in the former that the majority of students had positive attitudes on almost all features of the individualized learning. These were, for example, choosing their
own study programmed texts, choosing their own study places, choosing their own study time, study their own programmed texts, etc. But they did not like self-pacing. About 50% of students preferred passing over parts of information in the programmed texts. It was also found that 50% of students changed their attitudes positively in choosing their own sequence of topics, and self-study with programmed texts, from the pre-system stage to the end of the study unit stage.

As regards student perception of the structure of the study unit programmed text, it was found that most students of both classes recognized the roles and merits of almost all components provided in the study unit programmed texts. For example, they like the network diagram, illustrations to information, pre-test, post-test, exercises, pictorial sequence of operations, etc. It was also found that students had different needs of the amount of information for their learning.

There were 11 aspects of activities and components in the survey study into student perceptions into the new training system. It was found that 9 out of 11 aspects were perceived positively, and the rest neutrally on the positive side by the majority of ACC students. The majority of CC students, perceived 9 out of 11 aspects neutrally on the positive side; one aspect neutrally on negative side, and another was positive. The features which were perceived positively were, for example, learning objectives, workshop knowledge, pictorial quizzes, faults and remedies guides, the planning of sequence of operations, grading, report writing, etc. It was also found that the perception of many ACC students at this stage on planning, grading, and report writing was congruent with their expectations at the pre-system stage. And perception of both classes on workshop knowledge was congruent with their high ambition at the pre-system stage.

For the survey study on student perceptions into teacher's roles and programmed aids in the new training system, mixed results were found. Teacher demonstrations were more interesting, stronger emphasis, and more confidence lifting than self-studying with programmed workshop exercise leaflets. Whereas programmed workshop leaflets were easier to follow and to access than teacher help.

There were 22 comparative cases in the comparative survey study into student perceptions on activities and conditions in both the new and the traditional training systems. CC and ACC students
had similar perceptions in most cases. No single occasion was found in which both classes preferred conditions or activities provided in the traditional system and those in the new system. In contrary, 9 out of 22 cases which both classes preferred the activities or conditions provided in the new training system to those in the traditional system. However, the rest were demonstrations and help. It was also found that both classes preferred working on simple examples prior to actual production exercises to working with the actual production exercises right away.

In a comparative study into the degree of teacher involvement in student activities between the new and the traditional training system, there was no common ground for direct comparison. The comparative study was eventually done in terms of summarizing the highlights of some important features in relation to the degree of teacher involvement in each stage of the training of both systems. It was found that the degree of teacher involvement, in the new training system was either low or zero for both the study unit stage and the consolidating unit stage; and fair or low for both the practice unit stage and the exercise unit stage. It was found that the degree of teacher involvement was reduced slightly from the practice unit stage to the exercise unit stage on 8 out of 10 student activities. On the other hand no reduction was found in the degree of teacher involvement in student activities for the traditional training system. The degree of teacher involvement in this system was at a level slightly above the 'fair' and slightly above the 'low'.
8.1 OVERVIEW

In evaluating the training system as a whole, I began by formulating the concepts about the system, its components, functions and outcomes. After this, I pointed out areas to be evaluated in relation to the scope and capacity of my work. Then, the aims of the evaluation were set out as well as the criterion questions. These questions were generated from logical concepts of the systems functions and outcomes. They dealt with teachers, students, materials principles, working conditions, activities, and outcomes of students learning and training.

8.2 AIMS OF EVALUATION AND DECISION CRITERIA

In my training system, there were a number of aspects to be evaluated. These were:

- training stages
- study unit topic contents
- exercise contents
- student tasks
- teacher tasks
- training rules and conditions
- achievements of students (e.g., study unit, etc.)

In order to make a decision on the training system as a whole, I formulated the following criterion questions, set out below. If the system is acceptable, these questions must be answered positively based upon results gathered from earlier analyses and some to be presented in the following sections.

The criterion questions to system evaluation and the methods used to collect information to answer them are given in Table 8.1.
Table 8.1 Approaches and methods in evaluating the new training system in relation to the established criterion questions.

<table>
<thead>
<tr>
<th>Criterion Questions</th>
<th>Evaluation approaches/methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Were the training stages in the new training system acceptable in teacher's and students' opinions.</td>
<td>a) Student survey questionnaire into activities and components in the training system.</td>
</tr>
<tr>
<td></td>
<td>b) Teacher interview on course arrangement in the new training system.</td>
</tr>
<tr>
<td>2. Did students accept tasks, principles and working conditions provided in the new training system.</td>
<td>c) Student survey questionnaire into principles of individualized learning, structure of study unit programmed texts, activities and components of the new training system. Preferences of students regarding, activities, events and conditions in the new training system and the traditional one.</td>
</tr>
<tr>
<td>3. Did the workshop teachers accept principles and working conditions provided in the new training system.</td>
<td>d) Teacher interview on the use of network diagrams and selection of learning materials, student disciplines, workshop regulations and freedom of students, self-grading and other assessments.</td>
</tr>
<tr>
<td>4. Were teacher's burdens reduced satisfactorily in the new training system.</td>
<td>e) same as (d)</td>
</tr>
</tbody>
</table>

cont'd.....
Table 8.1 (cont'd)

<table>
<thead>
<tr>
<th>Criterion Questions</th>
<th>Evaluation approaches/methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Were the outcomes of the study unit stage satisfied.</td>
<td>f) Post-study unit stage tests and internal evaluation based on the 90/60 criterion standard.</td>
</tr>
<tr>
<td>6. Were outcomes of the consolidating unit stage satisfied.</td>
<td>g) Student responses on consolidating unit topics and internal evaluation based on the 90/60 criterion standard.</td>
</tr>
<tr>
<td>7. Did students progress satisfactorily on workshop exercises.</td>
<td>h) A goal free evaluation based on students' achievements on workshop exercises and tests.</td>
</tr>
<tr>
<td></td>
<td>i) Teacher interview on course arrangement, and student self-grading and other assessments.</td>
</tr>
<tr>
<td>8. Did students perform satisfactorily on workshop knowledge.</td>
<td>j) Post-course test results and external validation based on performances of other first semester first year skilled worker students.</td>
</tr>
</tbody>
</table>
8.3 RESULTS OF TEACHER INTERVIEWS

I had conducted a separate interview with two workshop teachers who supervised the CC class throughout the new training system. It was immediately after the end of the exercise unit stage (i.e., the end of the new training system), in January 1980.

The interviews were conducted in a similar way. I began with a short personal talk and then expressed the purpose of the interview. I asked for the teacher's plain opinions and his personal understanding and criticisms. Both teachers did not mind and allowed tape-recording during the interview.

Based on the results of teacher interviews, I summarized the important aspects in the following headings:

a) Teacher agreements to the outcomes of the training in the new and traditional systems.

b) Teachers' suggestions to the principles of the new training system.

c) Areas of weakness of the new training system.

e) Conclusions from teacher interviews.

f) Teacher agreements to the outcomes of the training in the new and traditional system

a) Teachers' agreements in the principles d) the new training system

The list given below is extracted from agreements made by both workshop teachers.

1. The training pattern used in the traditional system required workshop teachers to work hard and being very busy almost throughout the whole course.

2. Students in the traditional system must rely on teacher guidance and direction almost throughout the course.

3. Students of the new training system could use the given network diagrams.

4. Students of the new training system could work on themselves successfully to standards given in the drawing, and the proposed target time.

5. Students of the new training system could use grading sheets.
b) Teachers' suggestions to the principles of the new training system

The Table given below is from teachers' suggestions to some problems and the reasons for these suggestions.

<table>
<thead>
<tr>
<th>Problems</th>
<th>Suggestions</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students lacked concentration to study programmed texts outside the classrooms</td>
<td>Provide a specified place for students, e.g., library.</td>
<td>To prevent students from talking and playing during study.</td>
</tr>
<tr>
<td>2. Students could take advantage of the freedom to attend the cinema.</td>
<td>Students must attend the workshop every time.</td>
<td>To prevent students from going outside the workshop and misbehaving.</td>
</tr>
<tr>
<td>3. Properties of some students were gone missing.</td>
<td>Ban on students working during lunch.</td>
<td>No teacher looked after students during lunch.</td>
</tr>
<tr>
<td>4. Students wrote reports during working time.</td>
<td>New rule to prohibit students from writing reports during workshop time.</td>
<td>To use available training time in producing workpieces in time.</td>
</tr>
<tr>
<td>5. Students lack of good order in borrowing learning materials.</td>
<td>Advise students to queue in borrowing learning materials. Propose borrowing hours.</td>
<td>To make students in good order. To make things manageable.</td>
</tr>
<tr>
<td>6. A teacher had to get off from his desk quite often in order to give students learning materials.</td>
<td>Appoint some one to stand on this duty.</td>
<td>To allow a teacher to continue his work uninterrupted.</td>
</tr>
</tbody>
</table>
I do not quite agree to the teachers' suggestions, and have the following suggestions and reasons.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Suggestions</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>- Give constructive advice and encouragement.</td>
<td>- Students were unfamiliar to the new learning method.</td>
</tr>
<tr>
<td></td>
<td>- Provide more experience in self-study outside the classroom.</td>
<td>- Students could study comfortably and suitably to their own style.</td>
</tr>
<tr>
<td>2.</td>
<td>- Propose a time schedule for students.</td>
<td>- Condition students to work competively with the given time.</td>
</tr>
<tr>
<td></td>
<td>- Give shorter target time</td>
<td>- To maintain flexibility in working.</td>
</tr>
<tr>
<td></td>
<td>- Award more score on submitting work in time.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Give constructive advice.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>- Advise students to lock up their properties.</td>
<td>- Encourage students to behave nicely and respect for others.</td>
</tr>
<tr>
<td></td>
<td>- Advise students to take responsibility for other people and public properties.</td>
<td>- Provide working flexibility for enthusiastic students to work up to their limit.</td>
</tr>
<tr>
<td></td>
<td>- Allow working during lunch.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>- Give constructive advice in using training time efficiently.</td>
<td>- Provide working flexibility.</td>
</tr>
<tr>
<td></td>
<td>- No rules to restrict student working.</td>
<td>- Provide constructive working atmosphere.</td>
</tr>
<tr>
<td>5. and 6.</td>
<td>the same as teachers' suggestions.</td>
<td>the same as teachers' reasons.</td>
</tr>
</tbody>
</table>
c) **Areas of weakness of the new training system**

The table below shows areas of weakness of the new training system as mentioned by the teachers in the interview and my proposals for the solutions as well as reasons.

<table>
<thead>
<tr>
<th>Areas of Weakness</th>
<th>Proposals for Solutions</th>
<th>Reasons</th>
</tr>
</thead>
</table>
| 1. Some study unit topics were not applicable to workshop exercises. | - Conduct a survey into areas of topics to be given in the training course.  
- Validated training specification.  
- Discuss about a new workshop project to be suitable for students who attend the course in one semester. | - At present my training specification is not yet validated.  
- The present workshop project is hardly to be completed within one semester by average students.  
- To obtain information for design of study unit topics. |
| 2. Some study unit topics need more explanation. | - See results on evaluation of outcomes of study unit topics. | - Use objective method to identify areas of weakness of study unit topics. |
| 3. There were shortages of learning aids for some study unit topics. | - Conduct a pilot test on the use of learning aids in corporating with study unit topics.  
- Consider mass production using plastic materials for samples on measuring exercises or materials of low | - To get more reliable results for production of actual learning aids.  
- To obtain high precision samples.  
- To reduce cost in long term. |

cont'd....
<table>
<thead>
<tr>
<th>Areas of Weakness</th>
<th>Proposals for Solutions</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. (cont'd)</td>
<td>melting temperatures for die-casting samples on scribing or other exercises which consume materials.</td>
<td></td>
</tr>
<tr>
<td>4. There were too much details in grading sheets on students finished workpieces.</td>
<td>- Reduce number of measuring points by canceling some less important quality specification.</td>
<td>To reduce time in measuring and grading.</td>
</tr>
<tr>
<td>5. Grading students workpieces was done too often.</td>
<td>- Omit grading on some exercises which are less important.</td>
<td>To save time for other duties.</td>
</tr>
<tr>
<td>6. Some items in the assessment form for grading student reports were too subjective.</td>
<td>- Omit that item. - Rewrite it. - Provide examples for judgement.</td>
<td>To make all items highly objective.</td>
</tr>
<tr>
<td>7. Completion of all operations in producing workshop exercises was time consuming.</td>
<td>- Reduce quality specification to lower standards. - Maintain fundamental of correct working procedures, but no short cut.</td>
<td>To reduce production time. - To give a correct working basis for students.</td>
</tr>
</tbody>
</table>

cont'd......
### Areas of Weakness

<table>
<thead>
<tr>
<th>Areas of Weakness</th>
<th>Proposals for Solutions</th>
<th>Reasons</th>
</tr>
</thead>
</table>
| 8. Students delayed their working. | - Give constructive advice.  
- Propose a working time schedule and more score for submitting work within the target time. | - To encourage students to work faster.  
- To encourage students to continue a new work immediately.  
- To maintain working flexibility. |

#### d) Advantages of the new training system

The following is advantages of the new training system as mentioned in the teacher interviews.

1. The provision of study programmed texts minimized teacher load in giving workshop talks and lectures.
2. The provision of programmed exercise leaflets minimized teacher load in giving advice and guidance to students working.
3. The provision of grading sheets minimized teacher load in measuring students work repetitively.
4. Network diagrams provided more flexibilities for students selecting their learning materials and workshop exercises.
5. Teacher's approval of student grading provided immediate reinforcement and led to students' self-confidence.
6. Self-grading provided additional practice to students in measuring the quality of finished works.
7. Questions given in report activities provided an opportunity in review workshop knowledge and experience.

#### e) Conclusions from teachers interviews

During the presentation of each part of the teacher interviews I have made a number of conclusions. The collection of those conclusions is given in the following:
1. Teachers worked very hard in the early stage of the traditional training system.
2. Teachers accepted the arrangement of training stages in the new training system.
3. Example exercises are needed prior to actual production exercises.
4. Guidance was needed for student in the early stage of workshop practice in the new training system as well as the traditional one.
5. The arrangement of training stages together with the provision of self-learning materials provided in the new training system minimized the teacher's burden considerably as regards giving advice, lectures, workshop talks and quality of good works, to students.
6. Teachers prefered good order in the workshop, and students to attend the workshop every time, and study programmed texts in the specified places.
7. Provision of grading sheets minimize teacher tasks in giving constant advice to students about the quality of workpieces as well as repeatedly measuring students' unacceptable workpieces.
8. Students as well as teachers could use the given grading sheets.
9. Completion of grading for all students' finished workpieces was time consuming, due to too much detail in the grading sheets and a large number of students.

I have made one remark about the present workshop exercise project as not suitable for students who attended this course for one semester. I also suggested the need to design a new workshop exercise project to be completed within one semester.

8.4 EVALUATION OF OUTCOMES OF STUDY UNIT STAGE

There were 11 study unit topics to be evaluated in this section. I will present the results and discussions or suggestions in the following sequence:

a) outcomes of study unit topics.
b) areas to be improved of each study unit topic.
a) Outcomes of study unit topics

The outcomes of study unit topics were based upon the performance of students on the post-test of every study unit topic and compared with the predetermined criterion at 90/60 standard.

The summary of outcomes of all study unit topics is given in Table 8.2. From the results in this table, it indicates that there were only 3 study unit topics regarded as acceptable. They are:

1. Vernier calipers.
2. Files and the use of a file.
3. Techniques in filing flat work.

(Please look at table 8.2 on the next page)

By taking the results of the outcomes of all study unit topics into account, it can be seen clearly that the number of acceptable study unit topics was very small indeed (i.e., 3 acceptable study unit topics out of all 11 study unit topics). This gives enough indication to point out that the provision of study unit topics (in this case they were for benchwork theory) in the study unit stage was inefficient.

Now the question arises: what caused inefficient learning in study unit topics, particularly on those unacceptable ones? The prime causes for these results might be due to shortage or insufficient information or ambiguity of test items used rather than unfamiliarity of students to new learning methods or too much information.

There was enough evidence to eliminate the cause due to unfamiliarity of students to new learning methods. Results in my comparative studies between lecture and staff-study methods, as presented in chapter4, showed that students could learn in both methods equally well.

With regard to low achievements in study unit topics, a possible cause might have been too much information. However, in my observation this was not so, because the information given for each objective consisted of only one or two pages, including a series of pictorial illustrations, and there were only a few objectives. Time used for studying in general was limited to 60 minutes.

Thus the probabilities remain that information given was insufficient and that the test items used were ambiguous.
Table 8.2  Pass rate of CC and ACC students on 11 study unit topics at the 90/60 % criterion, at the end of the study unit stage.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Numbers of passing (%) at the 60 % level</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class</td>
<td>N</td>
</tr>
<tr>
<td>1. Vernier Caliper</td>
<td>CC</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Decision: Acceptable</td>
<td></td>
</tr>
<tr>
<td>2. Dial indicators</td>
<td>CC</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Decision: Unacceptable</td>
<td></td>
</tr>
<tr>
<td>3. Universal level protractors</td>
<td>CC</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Decision: Unacceptable</td>
<td></td>
</tr>
<tr>
<td>4. Techniques in measuring surface level and surface finish.</td>
<td>CC</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Decision: Unacceptable</td>
<td></td>
</tr>
<tr>
<td>5. Techniques in measuring squareness &amp; parallel surfaces</td>
<td>CC</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Decision: Unacceptable</td>
<td></td>
</tr>
<tr>
<td>6. Clamping work</td>
<td>CC</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Decision: Unacceptable</td>
<td></td>
</tr>
<tr>
<td>Topic</td>
<td>Numbers of passing (%) at the 60 % level</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>------------------------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Class</td>
<td>N</td>
</tr>
<tr>
<td>9. Layout work</td>
<td>CC</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Decision:</td>
<td></td>
</tr>
<tr>
<td>8. The use of files</td>
<td>CC</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Decision:</td>
<td></td>
</tr>
<tr>
<td>9. Techniques in filing flat work</td>
<td>CC</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Decision:</td>
<td></td>
</tr>
<tr>
<td>10. Chiselling</td>
<td>CC</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Decision:</td>
<td></td>
</tr>
<tr>
<td>11. Sawing</td>
<td>CC</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>ACC</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Decision:</td>
<td></td>
</tr>
</tbody>
</table>
b) Areas to be improved in each study unit topic

From the results presented in Table 8.2, it implies that there were some areas of weakness in most study unit topics. The technique used in determining these weaknesses is by means of test item analysis. In this case the value of test facility (D) index of each test item is used in comparison with the established criterion scale (i.e., above 80% acceptable) as approximated from the probability of 4 options multiple choice item. Results of the analysis are given in Table 8.3.

Table 8.3 Areas of weakness of 11 study unit topics as analysed from student response plot and items analysis.

<table>
<thead>
<tr>
<th>Topics</th>
<th>Test Item No.</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Vernier Caliper</td>
<td>2</td>
<td>Faults in using a vernier caliper.</td>
</tr>
<tr>
<td>2. Dial indicators</td>
<td>1 3B</td>
<td>Definition of measuring accuracy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Movement of indicators (test item was ambiguous).</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Faults in setting up a dial indicator.</td>
</tr>
<tr>
<td>3. Universal level protractor</td>
<td>1 3A 3B 5</td>
<td>Definition of measuring range.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reading scales of a universal level protractor (test item were not clear).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rules in storing and maining level protractors.</td>
</tr>
<tr>
<td>4. Techniques in measuring surface level and surface finish</td>
<td>2B 4A 4B 5C</td>
<td>Selection of measuring instrument for surface level (test was ambiguous).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Methods in checking surface texture.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Methods in checking surface level.</td>
</tr>
<tr>
<td>Topics</td>
<td>Test Item No.</td>
<td>Contents</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>5. Techniques in measuring squareness and parallel surface</td>
<td>1</td>
<td>Impact of surface finish on measuring the squareness.</td>
</tr>
<tr>
<td></td>
<td>4A</td>
<td>Techniques in measuring squareness and parallel surface of a cube.</td>
</tr>
<tr>
<td></td>
<td>4B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5A</td>
<td>Selection of measuring instruments for measuring parallel surfaces.</td>
</tr>
<tr>
<td></td>
<td>5B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>6. Clamping work</td>
<td>1</td>
<td>Selection of clamping jaws suitable for different types of shapes of work.</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Methods in clamping thin works.</td>
</tr>
<tr>
<td>7. Layout work</td>
<td>1B</td>
<td>Parallelo and cumulative errors.</td>
</tr>
<tr>
<td></td>
<td>1C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Reasons in using dye and mark punching on work surfaces.</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6A</td>
<td>Recognition of pointed angle of scribing equipment (eg, dividers, centre punch, scribers, etc.)</td>
</tr>
<tr>
<td></td>
<td>6B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Techniques in using a vernier highgauge.</td>
</tr>
<tr>
<td>8. The use of files</td>
<td>2D</td>
<td>Selection of a file suitable for different types of materials.</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Selection of a file suitable for different shapes of work.</td>
</tr>
<tr>
<td>9. Techniques in filing flat work</td>
<td>2</td>
<td>Faults in filing works.</td>
</tr>
<tr>
<td></td>
<td>4A</td>
<td>Position of the feet during filing.</td>
</tr>
<tr>
<td>10. Chiselling</td>
<td>1B</td>
<td>Types of chiselling works.</td>
</tr>
<tr>
<td></td>
<td>2A2</td>
<td>Selection of chisels suitable for different materials, shapes, sizes of work, and a correct cutting angle of chisels suitable for different materials.</td>
</tr>
</tbody>
</table>
Table 8.3 (cont'd)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Test Item No.</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Sawing</td>
<td>3A</td>
<td>Selection of a saw blade suitable for different types of materials.</td>
</tr>
<tr>
<td></td>
<td>3B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Techniques in sawing a thin-wall tube.</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Recognition of a correct sawing angle.</td>
</tr>
</tbody>
</table>

8.5 EVALUATION OF OUTCOMES OF CONSOLIDATING UNIT STAGE

8.5.1. AIMS OF THE EVALUATION AND RESULTS

There were four consolidating unit topics provided for student in the consolidating unit stage. This unit came after the study unit stage and the practice unit stage, but before the exercise unit stage. Its purpose was to facilitate students to recall the knowledge they had previously learned in the study unit stage and to integrate it with their experiences in the practice unit stage.

I will present the results on my evaluation on this part in the following headings:

a) Students' ability to recall workshop knowledge in consolidating unit topics.

b) Areas to be improved on workshop knowledge.

a) Students' ability to recall workshop knowledge in consolidating unit topics

The sum of all successful students for every consolidating unit topic is presented in Table 8.4. In this table I made another decision on the success of students as a whole for every consolidating unit topic, based on the 90% pass rate. The results in this case are presented at the bottom of each topic in Table 8.4. From these results, it was found that students as a whole could recall their previous workshop knowledge successfully for all four consolidating unit topics. This indicates that the result of each consolidating
unit topic was satisfactory in terms of student achievement.

The successful results of all consolidating unit topics in this case and the increase in the level of students' performance on benchwork theory at the end of the consolidating unit stage gave us an idea of the positive impact of the consolidating unit topics on student training in terms of workshop knowledge.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Class/Number of Students</th>
<th>Passing at 60% achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CU1</strong> Techniques in measuring</td>
<td>CC N = 13 (72.2%)</td>
<td>N = 13 (100%)</td>
</tr>
<tr>
<td></td>
<td>ACC N = 19 (95.0%)</td>
<td>N = 17 (89.5%)</td>
</tr>
<tr>
<td></td>
<td>Total N = 32 (84.2%)</td>
<td>N = 30 (93.8%)</td>
</tr>
<tr>
<td>Decision: Acceptable</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CU2</strong> Scribing</td>
<td>CC N = 13 (72.2%)</td>
<td>N = 13 (100%)</td>
</tr>
<tr>
<td></td>
<td>ACC N = 18 (90.0%)</td>
<td>N = 18 (100%)</td>
</tr>
<tr>
<td></td>
<td>Total N = 31 (81.6%)</td>
<td>N = 31 (100%)</td>
</tr>
<tr>
<td>Decision: Acceptable</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CU3</strong> Files and Filing</td>
<td>CC N = 12 (66.7%)</td>
<td>N = 12 (100%)</td>
</tr>
<tr>
<td></td>
<td>ACC N = 19 (95.0%)</td>
<td>N = 19 (100%)</td>
</tr>
<tr>
<td></td>
<td>Total N = 31 (81.6%)</td>
<td>N = 31 (100%)</td>
</tr>
<tr>
<td>Decision: Acceptable</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CU4</strong> Sawing</td>
<td>CC N = 12 (66.7%)</td>
<td>N = 12 (100%)</td>
</tr>
<tr>
<td></td>
<td>ACC N = 18 (90.0%)</td>
<td>N = 14 (77.8%)</td>
</tr>
<tr>
<td></td>
<td>Total N = 30 (78.9%)</td>
<td>N = 26 (86.7%)</td>
</tr>
<tr>
<td>Decision: Acceptable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8.4 Results of students' ability to recall workshop knowledge of four consolidating unit topics, at the 90/60 standard.
b) Areas to be improved on workshop knowledge

The results of areas of students' weakness on workshop knowledge on four topics areas on benchwork theory are given in Table 8.5. These results give additional information to the areas to be improved on study unit topics. At the same time, it indicates the areas in which students found it difficult to recall particular pieces of information previously learned at the consolidating unit stage.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Frame No.</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CU1</strong> Techniques in measuring</td>
<td>3</td>
<td>Rules in using vernier calipers.</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Calculation of hole distance.</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Features of straight edge.</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Selection of suitable instrument for checking parallel surfaces.</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Methods in checking parallel surfaces.</td>
</tr>
<tr>
<td><strong>CU2</strong> Scribing</td>
<td>12</td>
<td>Methods in constructing parallel and perpendicular lines by using the divider.</td>
</tr>
<tr>
<td><strong>CU3</strong> Files and filing</td>
<td>4</td>
<td>Selection of a file suitable for different lengths of work.</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Selection of a file suitable for different types of work.</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Selection of a file suitable for surface finish, and recognition of grades of files.</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Selection of a file suitable for different types of materials.</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Selection of filing methods suitable for different surface finishes.</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Selection a file suitable for correcting high spot areas on a work surface.</td>
</tr>
<tr>
<td><strong>CU4</strong> Sawing</td>
<td>3</td>
<td>Position in clamping saw works</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Table 8.5 Results from analysis of student responses plot and test item analysis indicating areas to be improved for student knowledge on benchwork theory.
8.6 ACHIEVEMENTS OF STUDENTS ON WORKSHOP KNOWLEDGE

8.6.1. AIMS OF THE EVALUATION

To evaluate the success of the new training system in this respect, I have formulated three criterion questions as follows:

1. Did students have as high a workshop knowledge as the previous students of this course, before the training?
2. Did students learn their workshop knowledge successfully by the end of the training?
3. Did students achieve as high a workshop knowledge as the previous students of this course, by the end of the training?

8.6.2. RESULTS

In this section I will present the results and the discussions on the performances of both CC and ACC students on workshop knowledge in two headings:

a) performance of CC and ACC students before the training course.

b) performance of CC and ACC students after the training course.

The average scores of both CC and ACC students at the pre- and post- course on both areas of knowledge are given in Tables 8.6 (a) and (b). At the bottom of these tables the average scores of the samples of the first semester first year skilled worker students are also presented.
### Benchwork Theory

<table>
<thead>
<tr>
<th>CLASS</th>
<th>Pre-system</th>
<th>Post-course</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>X</td>
</tr>
<tr>
<td>CC</td>
<td>18</td>
<td>29.7</td>
</tr>
<tr>
<td>ACC</td>
<td>16</td>
<td>27.4</td>
</tr>
<tr>
<td>SAMPLE</td>
<td></td>
<td>62</td>
</tr>
</tbody>
</table>

Table 8.6 (a) Test results of CC and ACC students on benchwork theory at the pre-system stage and the post-course.

### Technical Drawing

<table>
<thead>
<tr>
<th>CLASS</th>
<th>Pre-system</th>
<th>Post-course</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>X</td>
</tr>
<tr>
<td>CC</td>
<td>18</td>
<td>13.0</td>
</tr>
<tr>
<td>ACC</td>
<td>16</td>
<td>13.3</td>
</tr>
<tr>
<td>SAMPLE</td>
<td></td>
<td>87</td>
</tr>
</tbody>
</table>

Table 8.6 (b) Test results of CC and ACC students on technical drawings at the pre-system stage and the post-course.

a) Performance of CC and ACC students before the training course

The results of the pre-course on benchwork theory, shown in table 8.6 (a), indicated that both CC and ACC students performed equally as well (i.e., $\bar{X}(CC) = 25.7$ and $\bar{X}(ACC) = 27.4$). By comparing
the performance of both CC and ACC students at the pre-course to that of the sample of the first semester first year skilled worker students, it was found that performance of both CC and ACC students was lower than that of the sample by 15 and 18 marks respectively. These mean score differences of both classes and the sample were very much greater than 1 S.D. This indicated that the performance of both CC and ACC students on average at the pre-course on benchwork theory was statistically significant lower than that of the sample. These results could be explained as due to two main reasons:

1. Both CC and ACC students did not attend the course on metal trade principles (1) in the first semester, while all other first semester first year skilled worker students did.
2. Both CC and ACC students had not yet gone through the benchwork practice course, while all other first semester first year skilled worker students had.

From the statistical evidence and the above two reasons I am confident to conclude that before the training course both CC and ACC students had their knowledge on benchwork theory lower than the first semester first year skilled worker students.

On the technical drawing, the results at the pre-course of CC and ACC students in Table 8.6 (b) indicated that both CC and ACC students performed almost identically well (i.e., \( \bar{X}_{CC} = 13.0 \) and \( \bar{X}_{ACC} = 13.3 \)). As comparing the performance of both classes to that of the sample, it was found that performance of both CC and ACC students were lower than that of the sample by 3.6 and 3.3 marks respectively. The differences on mean scores between both classes and the sample was lesser 15.0 (i.e., about 4.4 marks). This indicated that there were no statistically significant differences between performances of both CC and ACC students and the sample at the pre-course on technical drawings. In this case the differences might be due to chance or error in measuring.

The reason for the lack of a statistical significant on this case could be explained as due to the fact that both CC and ACC students did attend the course on mechanical perception into technical drawing in the first semester as did all other first semester first year skilled worker students.
Since the contents of the test on technical drawing covered more areas than those taught in the course on mechanical perception into technical drawing, on the part of assembly drawing code of machine parts, and planning of sequence of operations, then a slightly lower performance of both CC and ACC students than that of the sample might be due to this aspect. This was because this section of knowledge was contained in the metal benchwork practice course.

But since there was not enough evidence to point out that CC and ACC students performed worse than the sample, thus I conclude that both CC and ACC students, before the training course, had as high a knowledge on technical drawing as those other first semester first year skilled worker students.

Referring to the first criterion question which I put forward as: 'Did students have as high a workshop knowledge as the previous students of this course, before the training?' At this stage I could answer this question, based on the above findings, as follows:-

1. Yes, CC and ACC students, before the training course had as high a knowledge on technical drawing as the first semester first year skilled worker students.

2. No, CC and ACC students, before the training course did not have as high a knowledge on benchwork theory as the first semester first year skilled worker students.

b) Performance of CC and ACC students after the training course.

As I considered the performance of CC and ACC students between the pre- and the post-course on benchwork theory, as shown in Table 8.6 (a), it was found that both CC and ACC students performed very much better at the post-course than at the pre-course. There, they outperformed by 24.4 marks for CC students and 27.8 marks for ACC students. These results were very much greater than 1 S.D. This indicated that the gain scores from pre- to post-course of both classes had statistical significance. This gives very strong evidence to conclude that both CC and ACC students learned their knowledge successfully in the training course on benchwork theory.

For the performance of CC and ACC students on technical drawing the gain score from pre- to post-course were used, as shown
in Table 8.7. From this table it indicated that both CC and ACC students improved their knowledge on technical drawing over the training course by 3.9 and 4.5 marks respectively. It was also found that these gain scores from pre- to post-course of both classes had statistically significance, at 99% confidence level. These results give enough evidence to conclude that both CC and ACC students acquired their knowledge of technical drawing successfully in this training course.

<table>
<thead>
<tr>
<th>Class</th>
<th>N</th>
<th>Pre-course</th>
<th>Post-course</th>
<th>Gain</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>S.D</td>
<td>X</td>
<td>S.D</td>
</tr>
<tr>
<td>CC</td>
<td>16</td>
<td>13.1</td>
<td>4.6</td>
<td>17.0</td>
<td>5.1</td>
</tr>
<tr>
<td>ACC</td>
<td>16</td>
<td>13.3</td>
<td>4.4</td>
<td>17.8</td>
<td>6.2</td>
</tr>
</tbody>
</table>

N = Number of Students  * * = p<0.01

Table 8.7 Gain Scores of CC and ACC students from pre- to post-course on technical drawing.

Up to this stage, I could answer the second criterion question (i.e., Did students learn their workshop knowledge successfully by the end of the training course?) as follows:

1. Yes, CC and ACC students learned their workshop knowledge on part of benchwork theory successfully by the end of the training course.
2. Yes, CC and ACC students learned their workshop knowledge on part of technical drawing successfully by the end of their training course.

Now I come to the comparison of student achievement on workshop knowledge between both CC and ACC students and other first year semester first year skilled worker students.

Refer to the average achievements of both CC and ACC students on benchwork theory at the post-course, and that of the sample in Table 8.6 (a), it was found that the former performed better than the
latter, as shown in Diagram 8.1 (a). Both CC and ACC students outperformed over the sample by 9.1 and 10.2 marks (or 12% and 13% for CC and ACC students) respectively. These amount of differences were very much greater than 1 S.D. This indicated that the differences had statistically significance. This give enough evidence to conclude that both CC and ACC students, by the end of the training course, performed better than the other first semester first year skilled worker students on benchwork theory.

For the technical drawing, the results in Table 8.6 (b) indicated that both CC and ACC students performed slightly better than the sample, by the end of their training. They outperformed over the sample by 0.4 and 1.0 marks (or 1.0% and 2.5%) for CC and ACC students respectively. These amount of differences were very much smaller than 1 S.D. This indicated that the differences had no statistically significance. So that, there was not enough evidence to conclude that both CC and ACC students performed better than other first semester first year skilled worker students on technical drawing. This was probably due to chance alone.

![Bar chart for Benchwork Theory and Technical Drawing](image)

<table>
<thead>
<tr>
<th></th>
<th>Sample</th>
<th>CC</th>
<th>ACC</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benchwork Theory</strong></td>
<td>58.4</td>
<td><strong>70.3</strong></td>
<td><strong>71.1</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Technical Drawing</strong></td>
<td></td>
<td><strong>41.5</strong></td>
<td><strong>42.5</strong></td>
<td><strong>44.0</strong></td>
</tr>
</tbody>
</table>

Table 8.1 Comparision of test performance between CC,ACC students and the first semester first year skilled worker students on both a) Benchwork Theory and b) Technical Drawing.
At this stage I have the answers of the third criterion questions (i.e., students achieve as high a workshop knowledge as the previous students of this course, by the end of their training?) as follows:

1. Yes, both CC and ACC students achieved their workshop knowledge on the part of benchwork theory successfully and were even better than the other first semester first year skilled worker students, by the end of their training course.

2. Yes, both CC and ACC students achieved their workshop knowledge on the part of technical drawing successfully as highly as the other first semester first year skilled worker students.

From the results above (see diagram 8.1), it can be seen clearly that the achievement of both CC and ACC students on benchwork theory was very much better than on technical drawing in two aspects; that is:

1. On the average achievement (i.e., about 70% for benchwork theory and 43% on technical drawing).

2. In relation to the achievement of the sample (i.e., there was a statistically significant difference on benchwork theory but not on technical drawing).

It is interesting to note that there were no study unit topics or consolidating unit topics given on technical drawing, but these were given on benchwork theory.

8.6.3. CONCLUSIONS AND SUGGESTIONS

From results found in this section I can conclude the main findings as follows:

1. With the provision of the system arrangement in the new training system, both CC and ACC students performed significantly better than the other first semester first year skilled worker students on the benchwork theory.

2. Without the provision of study topics on technical drawings in the new training system, both CC and ACC students could hardly have achieved as high a knowledge as that on benchwork theory.
I therefore, suggest the following measures in order to maintain student knowledge on the part of benchwork theory and technical drawing at a high or even higher a level in implementing the new training system:

1. Improve the quality of some study unit topics and consolidating unit topics as already suggested in Tables 8.3 and 8.5 respectively.
2. Provide some study unit topics and consolidating unit topics on technical drawing in the areas of:
   - Codes and symbols for machine parts, materials and tolerances,
   - Assembly views.
3. Provide the task enrichment of planning of the sequence of operations for workshop exercises in the exercise unit stage.

8.7 THE OVERALL CONCLUSION OF THE EVALUATION ON THE NEW TRAINING SYSTEM

With regard to the criterion questions for the evaluation of the new training system as a whole (as mentioned in Table 8.1), all answers to them would lead to the overall conclusion of the evaluation on the new training system. As discussed so far in this chapter, I have gathered sufficient evidence to answer all those criterion questions as follows:

Q1: Were training stages of the new training system acceptable with regard to teachers' and students' opinions?

Refer to item 2 of section 8.3 (e) of teacher interviews, I have concluded that teachers accepted the arrangement of training stages in the new training system, and refer to the conclusion on item 1, page 291, section 7.8.4. (b). I have concluded from the results of students' attitudes and preferences to activities, principles and working conditions in the new training system that students of both CC and ACC classes also accepted training stages, in the new training
system. From these conclusions I then could answer the criterion question above as 'Yes', training stages given in the new training system were acceptable with regard to both teachers' and students' opinions.'

Q2: Did students accept the tasks, principles, and working conditions provided in the new training system?

Refer to the conclusion on item 2, page 291, section 7.8.4 (b), I have concluded that students accepted the principles of self-learning, and self-training as given in the new training system. Refer to the conclusion on item 4, page 291, section 7.8.4 (b), I have left out some controversial aspects and concluded that students of both classes did accept some parts of the working rules and conditions imposed upon them in the new training system. Thus, so far, it can be seen that all conclusions gathered here provide a positive answer to the second criterion question, even though the conclusion on item 4 of section 7.8.4(b) was not perfect. I, therefore answer the criterion question as 'Yes', students did accept the tasks, principles, and some working conditions provided in the new training system.

Q3: Did the workshop teachers accept principles and working conditions provided in the new training system?

Refer to item 6 section 8.3 (e), I have concluded that the teachers preferred good order in the workshop, and students to attend the workshop everytime and study programmed texts in the specified places. The teachers also agreed to the principle of grading students' finished work, because it did help minimize their task in giving constant advice to students about the quality of finished works as well as repeatedly measuring students' unacceptable workpieces (see item 7 of the same section). But they preferred the contents in the grading sheets to be reduced and grading to be done on some important exercises in later stages. The teachers had pointed out some areas of weakness due to students' misadventures, as shown in 8.3 (a). But as a whole I would conclude that the teachers did accept in principle self-learning, self-training, and self-grading, but not absolute freedom given to the students in relation to students' attendance and self-management of
working time. I, therefore, answer the criterion question above as 'Yes and No'. I would answer this question as 'Yes' in the case of some working regulations, but that the details of students' freedom should be changed or modified.

Q4: Were teacher's burdens diminished satisfactorily in the new training system?

Refer to section 8.3 (d) on items 1 to 3, I have pointed out from teacher responses that study unit programmed texts, programmed exercise leaflets and grading sheets minimized teacher's loads very much in many aspects like giving lectures, workshop talks, advice, guidance to students. I, therefore, answer the criterion question as 'Yes, teachers' burdens were diminished satisfactorily in the new training system'.

Q5: Were the outcomes of the study unit stage satisfied?

Refer to the results of the post-study unit stage test on benchwork theory and technical drawing (see Table 5.8, 'T1 to T2', and Table 5.19, 'T1 to T2'), it was found that both CC and ACC students significantly improved their knowledge on benchwork theory significantly, but not on technical drawing. That means that the outcome of the study unit on benchwork theory was positively successful, but not on technical drawing. This was because there were study unit programmed texts given on benchwork theory but not on technical drawing. The result on the increase of student knowledge on benchwork theory was due to the provision of the 11 study unit programmed texts. Refer to the results of these study unit programmed texts (see Table 8.2), I have concluded that the provision of study unit topics at the study unit stage was insufficient.

From the results and conclusions above I, therefore, answer to the criterion question above as 'No', the outcomes of the study unit stage at the present were unsatisfied. It needs the improvement on some study unit topics as suggested in Table 8.3, and the provision of study unit topics on technical drawing.'
Q6: Were the outcomes of consolidating unit stage satisfied?

Refer to the results of four consolidating unit topics (see Table 8.4) it was found that all of them were acceptable in terms of student achievement on completion of pictorial quizzes. Its impact on benchwork was unclear, but it was believed that they had positive impact on the improvement of student knowledge on benchwork theory as the results on the increase of student knowledge on this area at the post-consolidating unit test (see Table 5.8, T2-T3) and a large amount of contribution due to 'other factors not measured' shown in Table 5.12.

Based on the results above I would answer the criterion question above as 'Yes, the outcomes of the consolidating unit topic stage were satisfied in terms of the outcomes of the consolidating unit topics themselves and the increase of student knowledge on benchwork theory'.

Q7: Did student progress satisfactorily workshop exercises?

Refer to the results of percentages of students passing the criterion level at 80%, shown in Table 6.8, together with teachers' confirmations from the teacher interviews; I have enough evidence to conclude that both CC and ACC students achieved their workshop practice on a whole successfully and satisfactorily within the period of the new training system. I, therefore, answer to the criterion question above as 'Yes, students progressed satisfactorily on workshop exercises'.

Q8: Did students perform satisfactorily on workshop knowledge?

Refer to the conclusion on this matter as given in section 8.6.3; I concluded that with the provision of the system arrangement in the new training system, both CC and ACC students performed significantly better than the other first semester first year skilled worker students of benchwork theory. Another conclusion was that without the provision of study unit topics on technical drawing in the new training system, both CC and ACC students could hardly achieve as high a knowledge as that on benchwork theory. Notice that students' knowledge on technical drawing was as good as the other first semester skilled worker students, despite the fact that they were from the poorer group of the first year skilled worker students.
I, therefore, answer the criterion question with the condition as 'Yes students did perform satisfactorily on benchwork theory, and if there were study unit topics given on technical drawing, then students would perform better in it than they were now.'

From the answers I gave to all the criterion questions above, it can be seen that 5 out of 8 questions could be answered positively and perfectly; for the rest, if there could be some improvement in the next stage, the prospects of the new training system could be predicted as a successful system for workshop training. At this stage of the evaluation, however, I would judge it as acceptable but not entirely satisfactory.
9.1 CONCLUSION

The original ideas which led to the new training system were to solve some difficulties existing in the traditional system, as presented in the 'Problem analysis' of chapter 1, namely:

- lack of systematic guidance and supervision.
- timetable unmatched between classroom teaching and workshop practice.
- overloaded duties for workshop teachers.
- students inexperienced in study skills.

The apparent outcomes of the new training system to the problems above were supported by evidence from teacher interviews, student questionnaires, and experimental studies. These were:

- The acceptance of both the subjects (i.e. CC and ACC students) and teachers of four successive training stages (i.e. study unit stage, practice unit stage, consolidating unit stage, and exercise unit stage) as designed from the systems approach on students' work distribution.

- The acceptance of the teachers of their duties which were minimized by the use of student self-studying and self-training.

- The successful results of student learning in different learning methods and conditions (i.e., self-study with study unit programmed texts and lectures, and self-study with commercial extracts with solutions given to exercises and no solutions given to exercises). This was discussed in chapter 4.
Since the new training system and materials were proto-types and were tested for the first time, mixed results were found with some success. These involved areas on students' achievements of both workshop knowledge and workshop skills, students' conduct, workshop regulations and duties of the teachers.

Workshop knowledge on the part of benchwork theory, discussed in chapter 5, and achievement of students were increased great and significantly at the end of the study unit stage, and continued gradually and significantly until the end of the exercise unit stage. But after a long period of the traditional system which followed in the second half of the semester, slight drops were found in both CC and ACC students, and it was significant for the latter. However, the achievements of both classes at the end of the course were significantly higher statistically than the sample of the first semester first year skilled worker students (see section 8.6.2 (b)).

In the technical drawing part where no study unit topics were available, performances of both CC and ACC classes were gradually increased slightly; and it was statistically significant at the end of the exercise unit stage. Slight increases also continued for both classes at the end of the course. At the end of the course both CC and ACC students performed as well as the sample of the first year skilled worker students on technical drawing (see section 8.6.1 (b)).

The difference between the two parts of workshop knowledge implied that if there might have been study unit topics available on technical drawing, both CC and ACC students would perform much better than they did in this case. In another aspect, if the status of both CC and ACC students were taken into account; the outcomes above seemed to suggest that the new training system would be functionally more efficient with good classes like machine-shop mechanic or electrical mechanic, as an example, than it was with these CC and ACC classes.

I would like to point out the necessity of study unit programmed texts and other enrichment tasks given to students after the study unit stage. In case there was no study unit programmed text available for students, then there was no guarantee that the teachers would give lectures or workshop talks to students. Or in case the teachers might have given lectures or workshop talks to students, it was still difficult in practice to evaluate the performance of the teacher – unlike study unit programmed texts which could be evaluated and improved regularly and would not be subjected to political confrontation or embarrassment.

342
Provision of study unit programmed texts, or other task enrichments in relation to workshop knowledge, like pictorial quizzes in consolidating unit stage and review questions, in report writing, were beneficial for students for review or reference to their previously learned knowledge anytime and anywhere. Without reviewing past knowledge, naturally, students would soon forget it and that means a great loss of students' effort and training. Analyses of factors contributing to the total achievement of students' knowledge on benchwork theory seemed to suggest that the increases of level of students' achievement in consolidating unit stage and exercise unit stage, were from the impact of pictorial quizzes and other activities concerned (see sections 5.7 (2) and (3)).

Both CC and ACC students at their early stage of workshop practice in the study unit stage, like other novices, could hardly get on with difficult tasks like filing, sawing, and chiselling, (see section 4.4.3). But they were capable of performing very well on easy tasks like layout and clamping work. On difficult tasks, they constantly needed guidance and advice from the teacher in correcting and shaping their movement and co-ordinating of tools, hands, arms, limbs, and the body. Soon after the post-study unit stage, they improved their performances considerably and maintained it well above the criterion level throughout the new training system (see section 6.7.2 (c)).

The achievement of students on workshop exercises and their capability to perform many workshop operations and task enrichments were recognized and confirmed by the teachers as evidenced in the teacher interviews (see section 8.3). The teachers found that students of the new training system were quick to grasp teachers' advice. The teachers judged from their impressions that students of the new system performed better than the others of the traditional system on workshop exercises. They thought, it might be due to additional practices of measuring skills in grading activity.

For students themselves, they thought they gained many benefits from pictorial sequence of operations, pictorial illustrations of good and poor work, grading sheets and grading activities (see Table 7.4). They preferred the structures in both the study unit topics and programmed exercise leaflets of my design (see Tables 7.6 (a) and (b)).
These were available for their personal use in the new training system, whereas in the traditional system they must rely on the teacher's instruction and directions. From the results of survey questionnaires on students perception into comparative roles of the teacher and programmed materials (see Table 7.5), students favoured many aspects of teacher demonstrations; but as getting help from the teacher was sometimes difficult, they preferred having the programmed exercise leaflet.

Despite good achievements of students on benchwork theory, only 3 of 11 study unit topics were acceptable in accordance with the pre-determined criterion standard 90/60. Areas to be improved for those unacceptable study unit topics are suggested in Table 8.3. For consolidating unit topics, all four of them were acceptable based on the same criterion standard as that of the study unit, even though, there were some parts to be improved as well. This was given in Table 8.5.

The present criterion standard 90/60 was below the usual standard found in many literatures which set up at 90/90 level. If all learning materials would be improved to the normal standard, then it could be conceivable that the outcomes of the prospective new training system could be higher than the present.

There were a number of areas of weakness in the new training system in respect of activities, principles, and working conditions. These areas of weakness were, for example: students lacked concentration on their study outside the classroom or the workshop, came to the workshop late, no teachers looked after students during lunch or in the evening, too much detail in the grading sheets, etc. All these weaknesses were discussed and suggestions are given in section 8.3.

Among the areas of weakness above there were controversial issues about learning freedom, workshop regulations, and students' discipline. For example, the teachers wanted control over students' conduct in the workshop, while many students preferred freedom to study in any place, no attendance check, working overtime or during breaks, rests during working hours, etc. The researcher discussed these matters to some extent and suggested some solutions (see section 8.3(b) and 8.3(c)).

In evaluating the training system as a whole, 8 criterion questions were formulated in relation to system components, functions, and aims. 5 out of 8 criterion questions could be answered positively
and satisfactorily. The rest were not entirely satisfactory and further improvements and modifications needed. The achievements obtained as the results of the new training system were on the reduction of the teacher's load, achievement of students on benchwork theory and workshop practice, but not on the reduction of time used to complete the present workshop project (the small vice) within the course.

9.2 FURTHER OUTLOOK

The course contents of the present course on metal benchwork practice did not provide sufficient information about the aims of the training and training specification; I would suggest that work should be done in this area.

Still, the problem of the present workshop project on the production of a small vice could not be solved with the new training system, despite the fact that students were allowed to work overtime and during breaks. This problem was due to the present project being too lengthy for students to complete within a semester. The consequence was that the teacher must always direct students in order to make a number of short-cuts. This was regarded as incomplete training and lacking in good basis for correct working and students development towards independence of the teacher. A new design of workshop project should be done in the next stage after the validation of the training course.

As it will be inevitable that some materials for students practising workshop exercises will be spoiled in the early stage of training, a new thinking should be on the use of low melting and renewable materials like tin or aluminium. The Institute should have its own small foundry plant capable of producing die-casting and sand-casting.

Similar thinking was on the production of a variety of identical work samples to be used for scribing, and measuring practice exercises prior to actual workshop exercises. Plastic injection or compression should be invested.
As regards successful learning of students by different learning methods, i.e., self-learning with my study unit programmed texts, lectures, and commercial extracts, I would like to suggest further development to be done on producing more study unit topics and other materials used in my training system on other topics for the metal benchwork practice course. Further researches should also be carried out into the use of different learning media such as tape-slide programmes, demonstration films on other workshop practice courses as well as laboratory practice. The outcome would be beneficial for both teachers and students concerned.

Standard tests as well as criteria for student achievements on both workshop knowledge and workshop practice should be constructed and established for validating the training course.

Workshop teachers, head of the workshop, and administrators concerned should discuss together the flexibility of students working in the workshop and limits for learning freedom of students. Contents of the discussion could be taken from a number of areas of weakness and suggestions given in my research.


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354


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Appendix A1 Components of the present workshop exercise project:
a small vice.
Appendix A2 An analysis of the processes involved for each part of the present workshop exercise project: a production of a small vice.

<table>
<thead>
<tr>
<th>Name of Part</th>
<th>Filing</th>
<th>Scribing</th>
<th>Sawing</th>
<th>Drilling</th>
<th>Assembling</th>
<th>Chiselling</th>
<th>Thread-cutting</th>
<th>Reaming</th>
<th>Scraping</th>
<th>Turning</th>
<th>Number of processes for each part</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Base</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>9</td>
</tr>
<tr>
<td>2. Clamping base</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>7</td>
</tr>
<tr>
<td>3. Fixed jaws</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>7</td>
</tr>
<tr>
<td>4. Movable jaw</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>6</td>
</tr>
<tr>
<td>5. Jaw plates</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
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<td>⬤</td>
<td>⬤</td>
<td>5</td>
</tr>
<tr>
<td>6. Guidance plates</td>
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<td>⬤</td>
<td>⬤</td>
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<tr>
<td>7. End cover plate</td>
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<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>6</td>
</tr>
<tr>
<td>8. Lead screw</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>7</td>
</tr>
<tr>
<td>9. Clamping base screw</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
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<td>⬤</td>
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<tr>
<td>10. Lead screw handle</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
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<td>⬤</td>
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<td>⬤</td>
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</tr>
<tr>
<td>11. Clamping base screw handle</td>
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<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>4</td>
</tr>
<tr>
<td>12. Lead screw sleeve</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>5</td>
</tr>
<tr>
<td>13. Sleeves for lead screw handle</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
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<td>⬤</td>
<td>⬤</td>
<td>4</td>
</tr>
<tr>
<td>14. Clamping base lead screw sleeve</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
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<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>4</td>
</tr>
<tr>
<td>15. Sleeves for clamping base handle</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>4</td>
</tr>
</tbody>
</table>

Number of Parts involving Processes | 11 | 9 | 15 | 13 | 15 | 2 | 6 | 5 | 2 | 8 | 86
### Production process: Filing

<table>
<thead>
<tr>
<th>Sub-system</th>
<th>Job knowledge</th>
<th>Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plans</strong></td>
<td>1. Isometric views, projection views.</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>2. Assembly views, explosion views.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Symbols and dimensions.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Drawing formats.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Operation plans.</td>
<td></td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td>1. Codes and colours of materials.</td>
<td>Measuring</td>
</tr>
<tr>
<td></td>
<td>2. Physical properties.</td>
<td></td>
</tr>
<tr>
<td><strong>Tools / Machines</strong></td>
<td>1. Files.</td>
<td>Filing various kinds of works, sizes, shapes, on metal and non-metal.</td>
</tr>
<tr>
<td></td>
<td>2. Techniques of filing.</td>
<td>Filing various kinds of works, sizes, shapes, on metals and non-metals.</td>
</tr>
<tr>
<td></td>
<td>3. Use of clamping devices.</td>
<td>Setting up work and use of clamping devices.</td>
</tr>
<tr>
<td></td>
<td>4. Rules for safety in filing.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Measurement of filed work.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Qualities of filed work.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. Fault finding, correction and prevention.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix  A4   An example of scoring and deciding workshop training needs.

<table>
<thead>
<tr>
<th>Sub-system: Plan</th>
<th>Score</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reading isometric views</td>
<td>3</td>
<td>Y Y ✓</td>
</tr>
<tr>
<td>2. Reading projection views</td>
<td>4</td>
<td>Y Y ✓</td>
</tr>
<tr>
<td>3. Reading assembly views</td>
<td>5</td>
<td>Y N ✓</td>
</tr>
<tr>
<td>4. Reading explosion views</td>
<td>2</td>
<td>N N X</td>
</tr>
<tr>
<td>5. Interpreting symbols</td>
<td>2</td>
<td>N Y ✓</td>
</tr>
<tr>
<td>6. Interpreting dimensions</td>
<td>2</td>
<td>Y Y ✓</td>
</tr>
<tr>
<td>7. Reading drawing formats</td>
<td>1</td>
<td>N N X</td>
</tr>
<tr>
<td>8. Reading operation sheets</td>
<td>5</td>
<td>Y Y ✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-system: Material</th>
<th>Score</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Interpreting codes and colours of materials</td>
<td>2</td>
<td>N N X</td>
</tr>
<tr>
<td>2. Identifying general physical properties</td>
<td>3</td>
<td>Y Y ✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-system: Measuring instruments</th>
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<th>Decision</th>
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<tbody>
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<td>1. Steel rules</td>
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<td>2. Vernier calipers</td>
<td>3</td>
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</tr>
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<td>3. Micrometers</td>
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<td>4. Dial indicators</td>
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<tr>
<td>5. Bevel protractors</td>
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<tr>
<td>6. Squares</td>
<td>2</td>
<td>Y Y ✓</td>
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<tr>
<td>7. Surface texture gauges</td>
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<tr>
<td>8. Straight edge gauges</td>
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<td>9. Ring and Plug gauges</td>
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<td>7. Fixing handles of files</td>
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<td>8. Measuring filed works</td>
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<td>2. Setting up feeds</td>
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<tr>
<td>3. Using 3 jaw-independent chucks</td>
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<td>4. Operating and stoping lathes</td>
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<td>5. Using centre drills</td>
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<td>14. Setting compound slide</td>
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<td>15. Setting tool post</td>
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<tr>
<td>16. Setting tailed stock</td>
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<tr>
<td>17. Setting tapered attachment</td>
<td>4</td>
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<tr>
<td>18. Measurement of turned work</td>
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APPENDIX A 5 Training goals of the workshop training course.

On completion of this training course, the student should be capable of:

1. Reading technical drawings in the SI-Unit system and symbols of DIN standards, given in the drawings.
2. Working with steel and/or other materials of various sizes and shapes.
3. Using measuring instruments in the SI-Unit system appropriate to the various types of production processes.
4. Using appropriate clamping devices, scribing, cutting and other small tools, for the production and assembly of finished work.
5. Producing from drawings work of acceptable quality by filing, sawing, chiselling, scraping, tapping, dieing, reaming, drilling, and turning. This would mean achieving at least the following dimensional accuracies:

<table>
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<th>Drilling &amp; Turning</th>
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<tr>
<td>Surface texture</td>
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<tr>
<td>Surface level</td>
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</tr>
<tr>
<td>Squareness</td>
<td>+ 0.05</td>
<td>+ 0.02</td>
</tr>
<tr>
<td>Internal and external length</td>
<td>± 0.1</td>
<td>± 0.05</td>
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</table>

6. Assembling and adjusting commercial and workshop produced machine parts in the completion of a given project.
7. Recognizing defects in materials, tools, equipment, machines, and workpieces, and taking corrective measures.
8. Observing workshop rules and regulations.

APPENDIX A 6 Training specification of the benchwork practice course.

The following contents should be covered in the training programme. And by the end of the training course, the student should be able to:

A. (Working drawings and Plans)

1. Read isometric views, projection views, and assembly views given in the SI-Unit system.
2. Interpret symbols for materials, machine parts and quality specifications given in DIN standards.
3. Follow and plan operation sheets for both production and assembly work.

B. (Materials)

1. Interpret codes and colours for ferrous and non-ferrous materials as given in DIN standards.
2. Identify general physical properties of the above materials.
3. Inspect the quality of given workstock with regard to the dimension specified in the drawings and identify any defects in the materials.

C. (Measuring instruments)

1. Describe, select, use and maintain in good condition the following:
   - Vernier calipers
   - Dial indicators
   - Universal bevel protractors
   - Squares
   - Surface texture gauges
   - Straight edge gauges

D. (Clamping)

1. Describe, select, use and maintain in good condition the following:
E. (Scribing)
1. Describe, select, use and maintain in good condition the following:
   - Vernier highgauge
   - Steel rules
   - V-blocks.

F. (Filing)
1. Describe, select, use and maintain in good condition various types and sizes of files.
2. Form by filing workpieces of various sizes and shapes including:
   - Flat surfaces
   - Angular surfaces
   - Slots and holes
   - Curve surfaces.
3. Detect faults and take corrective as well as preventative measures.
4. Inspect the quality of various sizes, types and shapes of filed work.

G. (Sawing)
1. Describe, select and use good quality saw blades.
2. Prepare work stocks in sizes and shapes ready for further forming operations.
3. Detect faults and take corrective as well as preventative measures.

H. (Chiselling)
1. Describe, select and use correct types of chisels appropriate for flat chiselling and punching.

I. (Scraping)
1. Describe, select and use correct sizes of flat scrapers for various sizes of flat work.
2. Prepare work surfaces for scraping.
3. Inspect the quality of scraped work.

J. (Thread cutting)
1. Identify various types, sizes and shapes of commercial screws, nuts, bolts and washers.
2. Describe, select and use good quality dies and taps to produce various sizes of metric threads.
3. Detect faults and take corrective as well as preventative measures.
4. Inspect the quality of internal and external threads.

K. (Drilling, countersinking and counterboring)
1. Identify correct types and sizes of drills, countersinks and counterbores appropriate to various type and sizes of materials.
2. Identify and use correct types of coolant for various types of materials.
3. Describe the function of the parts of drilling machines and correct procedures in setting up speeds, feeds, depth of drilling.
4. Use appropriate clamping devices for various sizes and shapes of drilling work.
5. Detect faults and take corrective measures as well as safety precautions in drilling including the use of extractors.
6. Inspect the quality of drilling, countersinking and counterboring work.
L. (Reaming)
   1. Identify correct types, sizes, and shapes of hand and machine reamers.
   2. Describe and use correct procedures in reaming blind and through holes with hand reamers.
   3. Detect faults and take corrective as well as preventative measures.
   4. Inspect the quality of reamed work.

M. (Turning)
   1. Identify correct types and shapes of various turning tools and tool holders appropriate to different types of turning work.
   2. Identify and use correct coolants for various types of materials.
   3. Describe functions of parts of lathes and correct procedures in setting up speeds, feeds, and stop dogs.
   4. Use 3-jaw independent chucks, with live and dead centres.
   5. Perform the correct setting of tools, work, speeds, feeds, and the correct positioning of compound slide, tool post slide and tailed stock.
   6. Form various sizes and shapes of internal and external turning work including facing, longitudinal turning, drilling and chamfering.
   7. Detect faults and take corrective measures, as well as safety precautions, to prevent damage to machine tools, equipment and workpieces in turning operations.
   8. Inspect the quality of turning work.

N. (Assembling)
   1. Identify the correct names, shapes and use of general small tools such as hammer, screw driver, pliers, wrenches, etc.
   2. Use small tools in assembling and adjusting machine parts both commercial and home products.
   3. Perform assembly machining such as assembly drilling.
   4. Detect, faults and take corrective measures as well as safety precautions and to prevent damage to tools, equipment, machines and workpieces in assembly work.
   5. Inspect the quality of assembly work.
APPENDIX A7 Terminal objectives of the study unit stage.

By the end of the study unit stage, the student should be able to achieve more than 60% of every study unit programmed text, and thereby should be able to:

1. State correctly the functions of the following tools and equipment in relation to the given types of materials and types of work.
   a) Measuring tools including vernier calipers, dial indicators, bevel protractors, surface texture gauges, squares, etc.
   b) Marking tools including vernier height gauges, scribers, V-blocks, etc.
   c) Clamping devices including vice jaws and clamps.
   d) Cutting tools including files, saws, and chisels.

2. Read and set up correctly scales of those measuring instruments mentioned above in accordance with the given illustrations.

3. Identify correctly the types of tools and equipment to be used for measuring, scribing, filing, sawing, chiselling, and providing safety guards in relation to given materials, sizes and shapes of work.

4. Identify suitable working techniques appropriate for:
   a) Measuring internal and external dimensions, surface textures, squareness, surface level, curves, and angels.
   b) Scribing straight and intersecting lines, radius and curve.
   c) Clamping solid work, profile work in metals and non-metallic materials.
   d) Filing slots, holes, curves, angels and rough and smooth surfaces on flat work.

5. State correctly the methods to be used in cleaning, maintaining and storing in good condition, tools, equipment and workpieces.

6. State possible mistakes which may lead to damage to tools, equipment and workpieces as well as suggest corrective measures in the various operations mentioned above.

7. Perform steps in production work according to given drawings and conditions including various operations mentioned above.

e) Sawing solid and profile work in different sizes, shapes and materials.

f) Chiselling flat work, slots, and punched drilled holes.
APPENDIX A 8 Terminal objectives of the practice unit stage.

By the end of practice unit stage, the student will be given a piece of work stock, a drawing, a list of operations, and a grading sheet; he should be able to:

1. Arrange the necessary tools, equipment and operation sheets in good order on his work bench.
2. Set up the work and/or the necessary safety guard suitably and firmly for working conditions and materials of work.
3. Use the necessary tools and equipment appropriate to the materials, sizes and shapes of work in measuring, scribing, saving, filing, and chiselling.
4. Produce a completed piece of work according to specified standards given in the drawing which will involve saving, filing, and/or chiselling. Dimensional accuracies should be as close as those specified in the training goals.
5. Clean and maintain tools, equipment and workpieces in good condition and always keep the working place clean and tidy.
6. Check and grade the quality of the work produced completely and correctly in accordance with the given quality grading sheet.

APPENDIX A 9 Terminal objectives of the consolidating unit stage.

Having been given four programmed quizzes, the student must complete all of them successfully. Thereby he will be able to:

1. Identify correct and incorrect features and functions of the given tools and equipment, as regards measuring, scribing, clamping, filing, saving and chiselling.
2. Detect suitable tools and equipment appropriate to the given materials and sizes, and shapes of work; including measuring, scribing, clamping, filing, saving, and chiselling.
3. Identify correct and incorrect work positions and tool directions used in the various operations mentioned above.
4. Identify faults and causes of the tasks set and operations mentioned above.
APPENDIX A10  Terminal objectives of the exercise unit stage.

By being given a piece of workstock, a working drawing, and a grading sheet, at the end of the exercise unit stage, a student should be able to:

1. Plan suitable sequences of operations and specify correct tools/equipment for the stated operations.

2. Arrange the necessary tools/equipment and operation sheets in good order on his work bench.

3. Set up the work and/or necessary safety guard firmly and in a way suitable to the conditions and materials of work.

4. Use the necessary tools and equipment appropriate to the materials, size and shape of the work as regards measuring, scribing, sawing, filing and/or chiselling.

5. Produce a complete piece of work according to specified standards given in the drawing, including sawing, filing, and/or chiseling. Dimensional accuracies will be conformed to the training goals.

6. Clean and maintain tools, equipment and workpieces in good quality and conditions, and always keep the working place clean and tidy.

7. Check and grade the quality of the work produced completely and correctly in accordance with the given quality grading sheet.
Appendix  All Network diagram of the study unit, practice unit, consolidating unit, and exercise unit stages.

**Study unit stage**

1. Vernier Calipers
2. Techniques in Measuring
   - Squareness and Parallel
3. Techniques in Measuring
   - Layout work
4. Surface level and Surface finish
5. Techniques in Filing
   - Flat work
6. Files
7. Use of the Saw and Sawing
8. Use of the Chisel and Chiselling
9. Clamping work
10. Dial Indicators
11. Universal Bevel Protractors

**Practice unit stage**

0. Parallel legs
1. End section
2. Smooth filing
3. Filing

**Consolidating unit stage**

0. Measuring work
1. Scribing work
2. Filing work
3. Sawing work

**Exercise unit stage**

0. End Plate
1. Jaw Plates
2. Guidance Plates
Appendix A12  Timetable for workshop training and classroom teaching on Metal Trade Principles(1).

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<th>Classroom teaching</th>
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<td>15-11-80</td>
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<td>Study unit stage</td>
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<td>Part 1</td>
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<td>Micrometers</td>
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<td>Used of the Reamers</td>
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<td>Dies and Taps</td>
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</tbody>
</table>

369
APPENDIX B1 An example of a complete programmed text on the techniques in filing flat work.

Study Unit 7
A (6-7)

Techniques in filing flat work

Benchwork Practice Course

Contents

<table>
<thead>
<tr>
<th>Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Objectives</td>
<td>1</td>
</tr>
<tr>
<td>Guide to study</td>
<td>2</td>
</tr>
<tr>
<td>Learning aids</td>
<td>2</td>
</tr>
<tr>
<td>Pre-test</td>
<td>3</td>
</tr>
<tr>
<td>The technique of holding a file</td>
<td>4</td>
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<tr>
<td>The technique of regulating</td>
<td></td>
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<td>filing forces</td>
<td>5</td>
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<tr>
<td>Directions in filing</td>
<td>8</td>
</tr>
<tr>
<td>Techniques in twist filing</td>
<td>11</td>
</tr>
<tr>
<td>Position of the feet</td>
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Institute for Educational Technology
University of Surrey
Guildford, Surrey

Surat Thairong; November, 1979

INTRODUCTION

Two essential factors in successful filing of flat work are the ability in using files and skills in co-ordinating movements. Repetitive practice is the important key to achieve these abilities and skills. However, a sound knowledge of the principle techniques of filing is of a crucially important precondition for practice. Therefore, in this programmed text you will be required to study the theory of filing technique and complete some practical exercises.

OBJECTIVES

After completing this programmed text, you should be able to:

1. Know the correct method of hold various sizes of files suitable for different filing work, such as rough and smooth filing.

2. Select suitable filing directions and state rules for regulating forces exerted on both the end and the handle of a file, as well as twisting forces on the handle of a file.

3. Demonstrate cross filing and transverse filing correctly in accordance with rules given for holding a file, positioning the feet and moving the hands, arms and body.
GUIDE TO STUDY

The following are suggestions for successful study and practice. You are advised to get a friend to give you his comments during your practice in this programmed text.

1. Complete the pre-test and then check your results.
2. Study the text and complete the accompanying exercises.
3. Progress through the programme according to given directions.
4. Complete your exercises prior to checking for the correct solutions.
5. Practice practical exercises together with your friend(s).
6. You may complete the post-test before the practical exercises.
7. Complete the post-test and then check your results, and make sure that you understand every part of the programme before you leave it.
8. Do not write anything on this programmed text, always maintain it in a good state.

LEARNING AIDS

In order to work with this programmed text you must have the following items:

1. A piece of steel  St. 37, 50 x 49 x 23.
2. A file 300 x 0.
3. A steel brush.
4. A straight gauge or a square.

YOU MAY PROCEED TO THE NEXT PAGE NOW

PRE-TEST

Please answer all test items in a separate answer sheet.

1. Which statement describes a correct method of holding a file for rough filing?
   a. The right thumb placed on the handle and the left thumb on the end of the file.
   b. The right thumb is placed on the handle and the palm of the left hand on the end of the file.
   c. The right index finger is placed on the handle and the palm of the left hand on the end of the file.
   d. The right index finger is placed on the handle and four fingers of the left hand on the end of the file.

2. From the picture on the right hand please draw an arrow to indicate the size of the force to be exerted on the end of the file, in relation to the force on the handle. The length of the arrow represents the magnitude of the force.

3. Which is the correct filing method for detecting high spot area on a file surface.
   a. Transverse filing.
   b. Longitudinal filing.
   c. Cross filing.
   d. Draw filing.

4. On the picture on the right, please draw arrows for two missing forces on the handle of the file.

5. Which statement describes the correct position of the feet for longitudinal filing?
   a. The left foot is at a slight angle to the vice jaw, whereas the right foot is at 45° to it.
   b. The left foot is almost parallel to the filing direction and the right foot is at 25° to the centre line of the vice.
   c. The left foot is at a slight angle to the filing direction and the right foot is at 70° to the centre line of the vice jaw.

WHEN YOU HAVE COMPLETED THIS TEST, CHECK YOUR ANSWERS ON PAGE 19.
Techniques in holding a file

Holding a file correctly and properly will contribute to success in filing and diminishing strain on the hand. The following are correct methods in holding a file for various types of work.

1. Preliminary step
   - Place the handle of the file on the middle of the right hand palm, its end should be in line with the middle line of the thumb.

2. Holding a large file This is for rough filing or first cutting.
   - Grasp around the handle
   - Place the thumb right along the center line
   - Place the left hand palm on the end.

3. Holding a medium file This is used for second cutting or medium finishing.
   - Grasp the handle in the same way as for a large file.
   - Hold the end of the file with the thumb on top and fingers beneath.

4. Holding a small file It is used for narrow work.
   - Grasp the handle with the index finger placed along the center line of the file
   - The left hand need not be used.

5. Finishing filing This is used for adjusting the surface level and smooth surfaces.
   - Grasp the handle with the index finger placed along the center line of the file.
   - Press four fingers slightly on top near the end of the file.
   - File with short strokes only.

6. For a closed hole Cutting force can be increased by...
   - Grasping the handle with the thumb placed on the center line of the file.
   - Increasing the pressure on the handle of the file by placing the left hand on top of the right hand.

Technique in regulating filing forces

Filing is accomplished by two movements: cutting (forward) and returning.

1. Cutting movement This is achieved by...
   - Pushing the handle of a file forward with the palm of the right hand.
   - Pressing the handle with the thumb and the end with the palm of the left hand.
   - Pushing the file forward continuously.

2. Returning movement This is achieved by...
   - Pulling the handle of the file backward with the right hand.
   - Resting the palm of the left hand on top of the end of the file and exerting no force.

3. Regulating filing forces

In filing flat work the file must be maintained at a constant level throughout the cutting movement. At the same time the cutting force on the workpiece must be constant. These requirements can be obtained by regulating the forces exerted on both the handle and the end of the file, and controlling the level of both hands.

The magnitude of force on the handle and on the end of the file can be divided into three phases as follows:

1. The First Phase
   - Press harder on the end of the file with the left hand than on the handle with the right hand.

2. Middle phase
   - Press both the end and the handle of the file with equal forces. That means, the force on the end of the file is gradually reduced as the same rate as the force on the handle is gradually increased.

3. Last phase
   - Press the handle of the file harder than the end.
EXERCISE 1

Please answer all the following items.

1. What should be the magnitude of the force on the end of the file in relation to the force on the handle as depicted in the right hand picture? Use the length of the arrow to represent the magnitude of the force.

2. How should the force on the end of the file be obtained in rough filing?

3. What are possible causes for the small slopes along both ends of the work as depicted in the right hand picture?

SOLUTIONS TO EXERCISE 1

The following are correct answers to exercise 1.

1. The force on the end of the file, in this case, must be smaller than that on the handle, see picture.

2. The force on the end of the file should be obtained by pressing on it with the palm of the left hand.

3. The small slopes along both ends of the work are due to the following:
   
a. the level of the file was not maintained.
   
b. on the first phase, the force on the handle is too large in relation to that on the end of the file.
   
c. on the last phase, the force on the handle is too small in relation to that on the end of the file.

WHEN YOU HAVE COMPLETED THIS EXERCISE
CHECK YOUR ANSWERS ON PAGE 7.
8
Direction of filing

To obtain good results the following techniques should be used.

1. Transverse filing This is used for rough filing, mainly to remove stock. The filing direction is perpendicular to the long edge of the work.

2. Longitudinal filing This is used for smooth filing. The filing direction is parallel with the long edge of the work.

3. Cross filing This is used for detecting as well as correcting high spot areas on a filed surface. The filing direction is at 45° to the long edge of the work. Any high spot area on a filed surface will be apparent from intersecting cross marks.

4. Draw filing This is occasionally used for correcting high spot areas on a thin-long surface. Only a single cut file is used. The file is held perpendicular to the long edge of the work and gently pushed forth and back directly on the high spot area. Both hands must hold around the body of a file close together and the thumbs placed on the side of the file.

EXERCISE 2

Please answer all the following:

1. Which filing direction is the most suitable for correcting high spot areas on:
   a. a large surface work, and
   b. a thin-long surface work.

2. Which type of cut with the file would you use for each task given on item 1.

3. Suppose you are going to remove the stock of a work shown in the right hand picture.
   a. Which of the two methods described below would you choose?
   b. Give your reason(s) of choosing it.

Method 1 First start at the left hand edge and file for 2-3 strokes and then continue filing with a constant number of strokes along the entire edge. Second start at the right hand edge and progress in the same way until reaching to the left hand side. Continue in this manner until the stock is brought to the required size.

Method 2 First start at the left hand edge of the work, file repeatedly until the stock is removed to the required size. Second move to the next adjacent area and repeat filing in the same way until the required size is obtained. Continue in this manner until the entire surface is leveled.

WHEN YOU HAVE COMPLETED THIS EXERCISE CHECK YOUR ANSWERS ON PAGE 10.
SOLUTIONS TO EXERCISE 2

The following are the correct answers to exercise 2.

1. a. You should have chosen the transverse filing for correcting high spot areas on a large surface work. Because filing in this direction will not repeat old file traces; but will produce a series of new traces which will readily reveal whether high spot areas are now leveled.

   b. You should have chosen the rub filing, but longitudinal filing would do the task as well, provided it is with gentle, short strokes and the file is held level.

2. a. For correcting high spot areas on a large surface a double cut file with a convex face is used (see picture).

   b. For thin long surface a single cut file with draw filing is used, the double cut file with longitudinal filing.

3. a. You should have chosen method 1.

   b. This is because the first method will remove stock equally along the entire surface and leave no 'steps' which are liable to occur with the second method (see picture).

Techniques in twist filing

It is quite likely that both side edges of a filed work will be under level as results from normal filing. This is because of unevenly distributed forces mounted on the side edges. The following are techniques to overcome this.

1. Even surface On a parallel edged surface cutting pressure upon the area being filed is equally distributed and results in even cutting forces. Consequently, filed stock is removed equally and leaves a level surface.

2. Uneven surface Suppose that a parallel edged surface is being filed with normal filing procedure, the cutting pressure in this case will be higher on the small contact area side than that on the large contact area side. Consequently a larger chip will be removed from the small contact area than the larger one, and a surface sloping down to the small contact area obtained.

3. A correcting method The sloping surface in the previous case can be overcome by adding a twist force towards the large contact area to the handle, see picture 3. This will equalize the cutting pressure on both large and small contact area and equal sized chips being removed and a level surface obtained. This twist filing should be applied to every type of work that falls into this category as shown in picture 4, for example.
EXERCISE 3

Please answer all the following.

1. In filing a flat work it is quite likely that both side edges of the work be be sloped down,
   a) what is the most likely cause for this result?
   b) what corrective measure would you use to overcome this poor result?

2. Which filing direction, given below, would you choose in filing an L-shape piece of work to obtain a level surface? The arrows represent the filing direction.

   a  b  c  d

SOLUTIONS TO EXERCISE 3

The following are correct answers to exercise 3.

1a) At both left and right edges of the work a file is likely to have gone over the edge as shown in picture 1. In this circumstance a higher cutting pressure is mounted on the outer edge than the inner side as shown in figure 1. Therefore, a greater amount is cut away on the outer edge than in the inner side, and consequently a sloping edge is obtained.

1b) A corrective measure in this case is accomplished by adding a twisting force on the handle of the file. Imagine a case shown in figure 3 where a file is placed far outside the work, it will tend to collapse. To get the file level again at this particular location, one must twist the file inward towards the work as shown in figure 4.

2. In filing an L-shape to a level surface, the correct filing direction is in option D. In this direction the distribution of cutting pressure is much better than in any other option.
Positions for the feet

A correct position for the operator when standing to file will facilitate filing movements and in turn good work will result. The following are the correct foot positions for filing.

1. Transverse filing This filing direction is suitable for rough filing.
   - the left foot is at 15°-25° to the centre line of the vice.
   - the right foot is about 60°-70° to the centre line of the vice.
   - the body is to the left of the vice.

2. Longitudinal filing This filing direction is suitable for smooth filing.
   - the left foot is at 15°-25° to the line of the vice jaw.
   - the right foot is about 60°-70° to the line of the vice jaw.
   - the body is to the right of the vice.

3. Cross filing This filing direction is suitable for detecting and removing high spot areas on the filed surface.
   - the left foot is at 15°-25° to the filing direction.
   - the right foot is about 60°-70° to the filing direction.
   - the body will be either on the left or the right of the vice, depending on the direction of filing.

Note: The span of the feet for all filing methods mentioned above is between 30 to 40 cm.

Movement in filing

Good work in filing results directly from a skillful co-ordination of movements of the body. The following are techniques in movement and use of filing forces.

1. Rough filing This is mainly for removing a large amount of stock. A heavy cutting pressure is obtained by forces exerted from hands and weight of the body. Picture 1 to 4 illustrate successive movements of the hands, arms, the left knee, the right leg and the body, from beginning until the end of the cut and the return.

2. Medium finish filing Accuracy, shape and surface finish are the main requirements. Movements in filing are the same as the previous ones but with moderate cutting pressure. More control and attention are needed.

3. Smooth finish filing A very smooth file is used. Great care and careful attention must be given to the accuracy of size, shape and surface finish. Movements are obtained from the hands only with a very light cutting pressure, see the method in holding a file for finish filing p. 4.

Notice Level of hands must always be maintained for all filing purposes as described above.
EXERCISE 4

This is the first practical filing exercise. You are advised to work with a friend who will be able to give you his comments.

A. Tasks You should perform the following:
   1. Demonstrate the correct way to hold a large file.
   2. Demonstrate the correct standing position for rough filing.
   3. File a piece of work in transverse filing direction as shown in the picture, for about 5 minutes.

B. Tools and equipment You must have the following:
   1. A piece of steel St. 37. 50x49x23.
   2. A file 300x0.
   3. A steel brush.
   4. A surface level.

C. Points to be observed Your friend should observe the following points while you are carrying out these tasks.
   1. The position of thumbs, fingers, and palms of the hand.
   2. The position of feet, legs, arms and body.
   3. The movement of the file, hands, arms, legs and body.
   4. Whether the filed surface is level, sloping or convex.

D. Discussion You and your friend should discuss your performance in terms of the observation points, and identify any mistakes or difficulties. You are advised to repeat this exercise again.

E. Techniques in filing Refer to page 4, 5, 11, 14 and 15.

When you have completed this exercise, go on to the next page.

EXERCISE 5

You should perform this exercise with a friend.

A. Tasks You should perform the following:
   1. Demonstrate how to hold a large file.
   2. Demonstrate how to stand for cross filing.
   3. File the piece of metal from exercise 4 to a flat level (use transverse filing to detect and correct high spot areas).

B. Tools and equipment You should have the same tools and equipment as in exercise 4.

C. Points to be observed Your friend should observe you with respect to the following points:
   1. The position of hands, arms, legs and body.
   2. The movement of tools, hands, arms, legs and the body.
   3. Check and interpret the filed surface.

D. Discussion You and your friend should discuss any mistakes and difficulties and find means to correct them. Observe difference between using the flat and convex faces in correcting high spot areas (see pictures below).

Flat side is used for reducing stock
Convex side is used for correcting high spot areas

You are advised to repeat this exercise again. If you are satisfied, then you may go on to the post-test.
POST-TEST

Please complete all the following items. Write your answers in a separate sheet.

1. For rough filing, you must grasp the handle of the file with your ____ on the centre line of a file and press the end of the file with your ____.

2. Sloping edges on the front of a filed surface result when the force on the end of the file is ____ than that on the handle.

3. To maintain the level of a file in draw filing both hands of the operator must hold a file = close together/far apart from each other =.

4. For cross filing your left foot must be at ____ to the direction of filing and your right foot is at ____ to the direction of filing.

5. When filing a smooth surface the operator should lean his body forward along with the movement of his hands = True or false =.

6. To prevent a slope on the left hand edge of a piece of work the operator must apply a twisting force on the handle = towards/away from = the work.

7. Transverse filing is used for = rough filing/second cut filing/smooth filing =

WHEN YOU HAVE COMPLETED THIS TEST, CHECK YOUR ANSWERS ON PAGE 20.

SOLUTIONS TO THE PRE-TEST

The following are the correct answers to the pre-test.

1. B.
2. The force on the end of a file must be larger than that on the handle, as shown in the picture on the right.
3. C.
4. Two missing force on the handle of a file are:
   a. pressing force and
   b. twisting force towards the centre of the work.
5. C.

ASSESSMENT

1. If your answers are all correct, you have very good knowledge on this topic. You may go on to the post test and complete practical Exercise 4 and 5 on pages 18 and 16 and 17 respectively.

2. If any of your answers are wrong, your knowledge of this topic is not sufficient. You should study at the particular section in accordance with your mistake(s) as follows:
   Item 1 study on page 4 and complete exercise 6
   Item 2 study on page 5 and complete exercise 6
   Item 3 study on page 8 and complete exercise 9
   Item 4 study on page 11 and complete exercise 12
   Item 5 study on page 14 and complete exercise 16

YOU MAY NOW GO ON
SOLUTIONS TO THE POST-TEST

The following are correct answeres to the post-test.

1. The thumb, the palm of the hand.
2. Smaller.
3. Close together.
4. $15^\circ - 25^\circ$ ; $60 - 70^\circ$.
5. False.
6. Toward the work.
7. Rough filing.

ASSESSMENT

1. If your answeres are all correct you have achieved all the objectives of this topic.
2. If any of your answers are wrong, you still have not achieved some objectives of this topic. You are advised to reconsider the test, or you may repeat your study of the particular section which corresponds to your mistake(s).
Appendix B2 An example of the practice unit programmed workshop exercise leaflet.

Practice Unit 1

Contents

<table>
<thead>
<tr>
<th>Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Performance objectives</td>
<td>2</td>
</tr>
<tr>
<td>A drawing</td>
<td>3</td>
</tr>
<tr>
<td>Activities</td>
<td>3</td>
</tr>
<tr>
<td>Question guide for planning</td>
<td>4</td>
</tr>
<tr>
<td>Pictorial sequence of operation</td>
<td>5</td>
</tr>
<tr>
<td>Faults and corrective measures</td>
<td>6</td>
</tr>
<tr>
<td>Hints for quality measurement</td>
<td>7</td>
</tr>
<tr>
<td>Grading sheet</td>
<td>7</td>
</tr>
<tr>
<td>Report tasks</td>
<td>8</td>
</tr>
</tbody>
</table>

Institute for Educational Technology
University of Surrey
Guildford, Surrey

Surat Thalitrong
September 1979
**Practice Unit 1**

**Filing legs of a U-shape**

**Introduction**
You have completed all the programme units in the study unit stage. Your knowledge and understanding on tools, production techniques and measurement of qualities of works are very crucial to and directly useful to your practical work.

This is the first practice exercise which is especially designed to provide you with an opportunity to practice your production skills and to familiarize with individual working processes. You are expected to produce a place of work according to standards given in the drawing.

Good results as well as proficiency in skills depend very much on the correct selection of suitable good quality tools, the correct use of tools, and careful attention and control of the movements to both tools and parts of the body. Awareness of faults and regular checking the dimensions of the work are also essential ingredients.

This exercise leaflet provide you performance objectives, a drawing questions guide to planing, a pictorial sequence of operations, faults and corrective measures, grading sheets and report activities.

**Performance objectives**
To complete this practice exercise you must have a piece of U-shaped steel U 75 x 100, and proceed through this programme text accordingly. The followings are your objectives.

During operation, you must be able to...

1. Use suitable tools and equipment correctly and safely in producing the work shown in the drawing, by following steps suggested in the pictorial sequence of operations.

2. Identify faults in your work and tools, and take suitable corrective measures by consulting hints given 'faults and corrective measures'.

By the end of this practice exercise, you must be able to...

1. Produce a perfect work according to the dimensions and accuracies stated in the drawing.

2. Check and measure your finished work correctly and completely in accordance with the items of the grading sheet.

3. Grade your finished work and complete the grading sheet correctly and score more than 80%.

4. Answer questions and complete all report activities according to the form given and obtain a score of more than 80%. 
Practice Unit 1  
Filing legs of a U-shape

Direction  Given below are the drawing and a list of your activities

Drawing

Materials: Steel St. 37  
Size: U 75 x 100  
Quantity: 1 piece

Activities  This exercise you are required to perform the following:
1. Make the layout on both legs of the U-shape work in accordance with the drawing.
2. Measure your layout and hence it approved by your supervisor.
3. File both legs of the work to 37 mm, measure the result, complete the grading sheet and submit both your work and the grading sheet to your supervisor.
4. File both legs of the work to 34.5 mm. and follow the same procedure as stated on item 3.
5. File both legs of the work to 33 mm. and follow the same procedure as item 3.


Introduction  To work systematically one should begin by studying the work to be done, planing its steps and anticipating possible mistakes and corrective measures. The list given below is guide for such planning.

Questions  It is recommended that prior to working you should answer all the following questions either to yourself or with a friend. To do this or not is your choice, and is not compulsory.
1. Should the layout be carried out on either leg or both legs?
2. How deep should the punched marks be made on the scribed lines?
3. How should the U-shape work be positioned in the vice, and in what direction?
4. Which face of the flat file should be used to remove dark scale of the work surface?
5. Which filing direction should you use?
6. How could you know that both legs of your work are at the same level?
7. How can you correct an unlevel surface on either leg of your piece of work?
8. How can you correct any high points on either leg?
9. How can you file both legs down equally and evenly?
10. How can you check the level of both legs?
### Practice Unit 1
#### Pictorial sequence of operations

**Filing legs of a U-shape**

**Introduction**

One essential factor which contributed to successful workings is to be able to work according to a plan. The pictures given below are the correct sequence of operations of this practice exercise.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Set up the vernier high gauge at 37 mm. and draw a line on both legs of the work.</td>
</tr>
<tr>
<td>2.</td>
<td>Draw a line on both legs by following the same procedure as item 1 for 36.5 mm. and 33 mm., respectively.</td>
</tr>
<tr>
<td>3.</td>
<td>Punch a series of marks about 10 mm. apart on all scribed line. The diameter of punched marks should be about 1 mm.</td>
</tr>
<tr>
<td>4.</td>
<td>Position the piece of metal with both legs upward, along the middle of the vice jaws with the base at the centre of the jaws.</td>
</tr>
<tr>
<td>5.</td>
<td>Turn the handle of the vice and clamp the work firmly, but over tight otherwise both legs will be bent inwards.</td>
</tr>
<tr>
<td>6.</td>
<td>File both legs together with a 300 x 0 file, advance gradually along both legs from left to right and back to the left.</td>
</tr>
<tr>
<td>7.</td>
<td>Continue pursuing until ( \frac{1}{2} ) or ( \frac{1}{3} ) of the punch marks disappear.</td>
</tr>
<tr>
<td>8.</td>
<td>Clean both legs with a brush, never your hands.</td>
</tr>
<tr>
<td>9.</td>
<td>Take the work out and check the level of your work along and across both legs.</td>
</tr>
<tr>
<td>10.</td>
<td>Measure either leg at least 3 positions: both ends and at the middle. Notice any fault.</td>
</tr>
<tr>
<td>11.</td>
<td>Relclamp the work and make corrective filing: if there is any fault, otherwise proceed to the next round in the same process.</td>
</tr>
</tbody>
</table>

---

**Faults and corrective measures**

### Faults

<table>
<thead>
<tr>
<th>Faults</th>
<th>Possible Causes</th>
<th>Corrective measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unevenly sizes</td>
<td>- The movement of the file is not level.</td>
<td></td>
</tr>
<tr>
<td>Stopped edges</td>
<td>- Too much force on the handle of the beginning, and too much force on the end of the file at the end of the stroke.</td>
<td></td>
</tr>
<tr>
<td>Unevenly surface</td>
<td>- The speed of moving from one end to the other on both legs is not constant.</td>
<td></td>
</tr>
</tbody>
</table>

**Possible Causes**

- Control the level of the file during cutting.
- Regulate forces on both the handle and the end of the file accordingly.
- Use cross filing on high spot, if there are a few large high spots.
- Use longitudinal filing on either leg and file with short stroke, if there are a number of small high spots.
Practice Unit 1
Hints to quality checking and grading sheet

Filling legs of a U-shape

Good work

1. Evenly surface
2. Punched marks remained halves

Poor work

1. Unevenly surface
2. Damaged edge
3. Stopped edges
4. Unequally sizes

Grading sheet

<table>
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<tr>
<th>No.</th>
<th>Description</th>
<th>Obtained size</th>
<th>Score Obtained</th>
<th>Score Possible</th>
</tr>
</thead>
<tbody>
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<td>Height 37 ± 0.25</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>Surface level +0.2</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Height 34.5 ± 0.25</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>Surface level +0.2</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>Height 33 ± 0.25</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>Surface level +0.2</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td>72</td>
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</tbody>
</table>

Total obtained score = ______%
Appendix B3  An example of the programmed quizzes used in the consolidating unit stage.

Consolidating Unit 3

Use of the file and filing

Benchmark Practice Course

Institute for Educational Technology
University of Surrey
Guildford, Surrey
Surat Thaitrong
September 1979

Contents

<table>
<thead>
<tr>
<th>Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Learning objectives</td>
<td>2</td>
</tr>
<tr>
<td>Suggestion for use</td>
<td>3</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>4</td>
</tr>
<tr>
<td>Programme quizzes</td>
<td>6-21</td>
</tr>
</tbody>
</table>

Introduction

You finished all the study units a few weeks ago, and recently all practice units. You may realize at this stage that knowledge and understanding of previous studies are useful for practical work. In the next training stage however there will be no guidance given to you as there was in the practice units.

This consolidating unit stage is designed to help you link experiences from the last stage to the next one. It is expected that programme quizzes given in a number of consolidating units will integrate your previous knowledge and experiences so that you will be able to carry out confidently all required tasks in the next stage.

This unit contains a number of essential parts of knowledge and experiences on 'The use of the file and filing'.
Learning objectives

From the series of pictorial quizzes given in this unit you should be able to answer all the questions correctly taking less than one minute for each.

Suggestion to use

To fulfil the objectives stated earlier you are advised to:

1. Record your starting time and the finishing time.
2. Read each question and discriminate each picture carefully before answering.
3. Write your answer to each question in a separate sheet.
4. Check the correct answer on top of the next page.
5. Proceed to the next question if your answer was correct otherwise restudy the question and the picture again before proceeding to the next question.
6. Continue until completion.
7. You can study this unit any where you like.

Prerequisites

To study this unit you must have completed all study units and all practice units given in accordance with the network diagrams.
1. Give one example of work which can be done with each of the above jaws.

Answer 1: A. Rough surface works  B. Smooth surface works  C. Cylindrical works

2. Which is the correct picture showing the most suitable clamping position?
Answer 2: B. Because the jaws are clamping at the strongest part of the U-shape whereas in C the position is too low and the U-shape may be bent.

3. Which is the correct clamping position for filing the shoulders on the right?

Answer 3: A. Because the clamping forces are distributed evenly along the entire length. In B, the legs would be bent as the supporting areas were less than in A.

4. How long should be the file to be used for filing the shoulder?

Answer 4: The length of a file should be about 150-200 mm. A shorter file will cause some difficulty in holding and filing. Whereas a longer one will be too difficult to maintain the level of the filing movement.

5. What should be the length of the file to be used for filing the cross section of the square rod?
11
Answer 5: The length of a file should be about 200-250 mm. Reasons are the same as the last answer.

6. Which type of a file will not cause damage on the side of the square hole?

12
Answer 6: A: There is no contact between the side of the triangular file and the side of the square hole.

7. Write down the codes for the grade of cut of files to be used for producing surface finishes as shown on the picture.

13
Answer 7: A = grade 3  B = grade 2

8. Which type of cuts of files are suitable for the stated materials?
9. Which is the correct illustration of correcting a high surface as well as producing a smooth surface?

Answer 9: A and B

10. Which filing work does require a twist force during filing?

Answer 10: C: As the file is leaning outside of the edge to be filed. This will cause an unevenly distributed cutting forces under the contact areas of the file, and the edge of the work will be sloped unless a twist force is applied.

11. Which piece of work is suitable for draw filing in order to reduce high surface spots?
17
Answer 11: B: Draw filing is suitable for thin works only.

12. Which side of a flat file is suitable for correcting the high spot areas here?

18
Answer 12: The convex side.

13. All pieces shown on the picture have been mark punched. Which picture does imply a correct size has been obtained?

19
Answer 13: B: Since punched marks are on the scribed line, half of those marks must be disappeared when the correct size is reached.

14. What is a possible cause of long scratches obtained here while filing?
Answer 14: Clogged file teeth.

15. Which picture is desirable for a complete work?

Answer 15: B: It is generally agreed that a perfect complete work must have smooth filed edges at 45°.

Well done if you have completed all questions correctly within 15 minutes.

Now you may go on to the next unit.
Appendix B4  An example of the programmed workshop exercise leaflet used in the exercise unit stage.

Exercise Unit 3
A 0-3

Guidance Plates
B 1 - 05 / 1 - 2

Benchwork Practice Course

Contents

<table>
<thead>
<tr>
<th>Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Exercise guide</td>
<td>2</td>
</tr>
<tr>
<td>Training objectives</td>
<td>3</td>
</tr>
<tr>
<td>Your exercise</td>
<td>4</td>
</tr>
<tr>
<td>Activities and a drawing</td>
<td>5</td>
</tr>
<tr>
<td>Grading sheet</td>
<td>6</td>
</tr>
<tr>
<td>Report activities</td>
<td>7</td>
</tr>
</tbody>
</table>

Introduction

You may realize at this stage that your skills are improving gradually as result of previous practices. You may also remember that there were in the practice unit stage the questions leading to planing, a pictorial sequence of operations, common faults/remedies provided to facilitate your working.

Now consider the skilled operators whom you may come across and ask yourself questions like:

1. Do skilled operators have operation plans to work with?
2. Where do they get operation plans from?
3. Do they make mistakes often?
4. Is there anyone telling them how to correct mistakes?
5. How good are their skills and proficiency?

Answers to these questions are the aims of this exercise unit stage. You are, therefore, expected to do a number of tasks as if you were a skilled operator yourself. You must have full responsibility for your work, tools, equipment and workplace. You are expected to be able to work on your own with or without minimum help from friends or your supervisor.

With a little more of dedication and attention from you your supervisor can certainly assure that you will eventually be successful in your training.

Institute for Educational Technology
University of Surrey
Guildford, Surrey

Surat Thairong
September, 1979
Exercise guide

The following are suggestions for your work.

1. Read this leaflet thoroughly and make sure you understand the training objectives and the section called 'Your work'.
2. Study the drawing carefully before making your own operation plan. You may work with a friend at this stage.
3. Get your work-stock and make sure all dimensions are as stated in the drawing.
4. Prepare your tools and equipment and make sure they are in good conditions.
5. Work according to the plan and always pay attention to the sizes and surface level of the work. You may refer to 'fault/remedies' in previous units or consult with your friend(s) in case you have some difficulties.
6. Complete the grading sheet when you have finished your work completely.
7. Clean your tools, equipment and workplace regularly and after work, keep them in good order. Always use the correct equipment for this, never bare hands.

Training objectives

To fulfil this exercise you should be able to....

1. Make an operation plan suitable for the production of the piece of work in the given drawing. The operation plan should contain details of each step of operation and tools/equipment to be used.
2. Use good quality tools and equipment safely and correctly and ensure they are suitable for the material and size of work being produced in each step of the operation.
3. Produce the piece of work from the given stock of materials in accordance with the standards stated in the drawing and within the predetermined time.
4. Measure and check the quality of the work produced correctly and completely to within 70% or more of the standards given on the drawing.
5. Complete the grading of the work produced correctly to with 70% or more in accordance with the given grading sheet.
6. Organize and maintain tools/equipment, work and working space in good order throughout the operations.
7. Answer all questions and complete other report activities correctly and completely with a score of more than 80% within 3 days.
Your work

The exercise you are going to undertake is to produce two guidance plates. The given material contains two guidance plates.

Both guidance plates when assembled to the whole unit of a vice will guide the movements of the movable jaws (see p.93, Metalwork practice 01.G).

If the height of the inner shoulder of either or both guidance plates were not equal or evenly level they might jam or loose their grips on the movable jaws. Therefore, their essential requirements are:

1. that the surface be level and that the inner shoulder be square.
2. the height of the inner shoulder should be $5 \pm 0.5$.

Notice that contents in this exercise are parts of the complete guidance plates. They might be drilled and have threads cut in the later stage. Results on this exercise will to some extent influence the perfection on the final result.

Exercise Unit 3

Activities and a drawing

B1-05 / 1-2

Direction

The following are a list of activities required to complete this exercise and the drawing.

Activities

In order to achieve the training objectives stated earlier you must have a steel St.37, 82x40x25 and perform four tasks as follows:

1. Plan an operation sheet.
2. Produce two guidance plates.
3. Complete the grading sheet.

Material: St.37 Size: 82x40x25
Quantity: 2 Time: 15 hours

Reference

Exercise Unit 3
Grading sheet
B 1 - 05 / 1 - 2

Good results

Chamfer 1x45° all edges

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<thead>
<tr>
<th>Side</th>
<th>Description</th>
<th>Measurement Obtained</th>
<th>Score Obtained</th>
<th>Score Poss.</th>
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<td>12</td>
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</tr>
<tr>
<td></td>
<td>Surface texture 0.8 μ</td>
<td></td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Surface level +0.05</td>
<td></td>
<td>12</td>
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<tr>
<td></td>
<td>Surface texture 0.8 μ</td>
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<td>12</td>
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<td>3</td>
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<tr>
<td></td>
<td>Surface texture 0.8 μ</td>
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<tr>
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<td>5</td>
<td>Surface level +0.05</td>
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<td>12</td>
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<tr>
<td></td>
<td>Surface texture 0.8 μ</td>
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<td></td>
<td>Thickness 5±0.5</td>
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<td></td>
<td>Surface texture 0.8 μ</td>
<td></td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Height 14±0.5</td>
<td></td>
<td>12</td>
<td></td>
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</tbody>
</table>

Total obtained score = _____ %

Exercise Unit 3
Guidance Plates
B 1 - 05 / 1 - 2

Report activities

Direction The following are a list of report activities and questions related to the production of guidance plates.

Activities You are expected to complete the following activities.

1. Answer all questions given below.
2. Present your operation plan of this exercise.
3. Report faults and difficulties in producing the guidance plates and suggest corrective measures.

Questions
1. What are the advantages and disadvantages in using either side 17x80 or side 12x80 as the reference base?
2. What is the reason for the tolerance given to the top edge of the inner shoulder (5 mm.) being larger than that given to the height (12 mm.)?
3. What problem is likely to occur if a 150x3 file is used in filing the inner shoulder? Which type of file would be suitable in this case?
4. Explain your techniques in correcting high areas at the middle of the inner shoulder.
5. Explain how you measure the parallel between the inner shoulder.

Reference Study Unit A (1-5) and A (1-7)
Appendix B5 An example of objectives on the use of the saw.

Objectives: The use of the saw
Benchwork Skills Practice
Surat Thaitrong
November 1980

The list given below is of the learning objectives on the use of the saw.

By the end of this topic, you should be able to:

1. Define correctly the sight clearance of a saw blade.
2. Select the correct saw blade for a workpiece of various types, sizes and material.
3. Identify correct methods in clamping saw-work of various sizes and shapes including thin sheet metals and thin-wall tubes.
4. Given the reasons for common errors in sawing work.

Appendix B6 An example of objectives, exercises and test on the use of the chisel.

Objectives: The use of the chisel.
Benchwork Skills Practice
Surat Thaitrong
November 1980

The list given below is of the learning objectives on the use of the chisel.

By the end of this topic, you should be able to:

1. Identify correctly three (or at least two) types of chiselling work.
2. Select the correct types of chisel and state their names and correct cutting angles for various materials and tasks.
3. Identify the correct method of holding various types and sizes of chisels and state the correct angle of the chisel for various tasks.
4. State correct measures for preventing accidents in chiselling.
Exercise 1: The use of the chisel

Benchwork Skills Practice

Surat Thairong
November 1980

Please complete all the following items. Write your answers on a separate sheet.

1. What are the types of chiselling work shown in the pictures on the right?
   a. Type: ............
   b. Type: ............
   c. Type: ............

2. What is the possible result that will occur if the chisel is held at an angle of 30° when working on a steel sheet?

3. What result will happen if it is hit with a chisel as shown on the right?

4. Which type of a chisel would you use to:
   a. Cut a 100 mm. ring on a 1 mm.-thick steel sheet?
      Chisel: ............
   b. Punch a series of drilled holes on a steel block 50 x 50 x 20 mm.?
      Chisel: ............
   c. Cut a cross-groove of 5 mm. depth on a steel block?
      Chisel: ............

Exercise 2: The use of the chisel

Surat Thairong
November 1980

Please complete all the following items. Write your answers on a separate sheet.

1. Give reasons for the differences in setting a flat and a round cold chisel to cut thin sheet metal along a scribed line.

2. a. Why is it necessary to have a piece of metal underneath the work to be chiselled?
   b. Name the material of that sheet of metal.

3. Why is it necessary to change the direction of chiselling to the position shown in the picture when it comes to the edge of the work?

4. If a rectangular hole 30 x 60 mm. is to be cut by drilling and punching, see the picture,
   a. What size of drill should be used if a 1 mm. hole margin must be maintained?
   b. How many holes should be drilled?

5. What corrective measure can be taken to prevent any accident from the mushroom head of a chisel?

6. On what should the operator keep his eyes on during chiselling?
The following are test items about the use of the chisel. Please answer all test items and write your answer on the answer sheet.

1. What types of chisel work are shown in the pictures on the right?
   a. This type is called ...........
   b. This type is called ...........

2. From the pictures given below, please identify the type of chisel which should be used and state the correct cutting angle.

   1) 1.a Type of a chisel ..........
       1.b Cutting angle ..........

   2) 2.a Type of a chisel .......... 
       2.b Cutting angle ..........

   3) 3.a Type of a chisel .......... 
       3.b Cutting angle ..........

   4) 4.a Type of a chisel .......... 
       4.b Cutting angle ..........

3. In the picture given on the first, there is one piece of equipment missing. Name the missing equipment.

4. In the first round of chisel traces made with a flat cold chisel on a scribed line, it is good practice for the operator to hold the chisel at an angle to the direction of chiselling. True or false?

5. During the chiselling your eyes must be watching the cutting edge of the chisel. True or false?

6. If the chiselling angle is too high during flat chiselling, the depth of cut in the workpiece would be decreased / increased?

7. The correct method of holding a 100 mm chisel, is for the operator to hold it with his ............fingers.

8. To protect other operators from being hit by flying waste, you must place ............. in front of your chisel?

9. Which picture below shows the correct method of wedging the head of a hammer?

   a)  
   b) wedge  
   c)  
   d)
Appendix B7  An example of the practical exercise in sawing and chiselling given after the completion of theoretical study.

Exercise : Sawing and Chiselling  Surat Thaitrong
Course : Benchwork skills Practice  November 1980

Direction : This exercise is part of your skill training. It gives you an opportunity to apply your knowledge to perform activities in sawing and chiselling.

Given : To perform this exercise you must have the following:
1. A piece of steel St  37  60 x 80 x 2 mm.
2. A flat cold chisel
3. A hammer
4. A saw blade 32 teeth/25 mm.
5. A saw frame, and
6. A vernier high gauge

Task : You are required to cut a slot and reduce a shoulder on the left hand side along the dotted line and the broken line to the dimensions given in the drawing, by using saw and chisel.

Drawing : 

+-----------------------------------+
| 30                                 |
| [----]                               |
| 20                                 |
| [-----]                              |
| 60                                 |
| [------]                             |
| 2 thick                             |
| [-----]                              |
| 60                                 |

Appendix B8  An example of the observation sheet used on sawing and chiselling during the first trial of students in the study unit stage.

Tasks : Sawing and Chiselling

Student : Suee  Class : ACC
Observer : Surat  Date : 14 Nov 80

<table>
<thead>
<tr>
<th>Activity</th>
<th>Decision (✓/✗)</th>
<th>Faults / notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Sawing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Clamping the workpiece in the vice</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2. Selecting a suitable saw blade</td>
<td>✗</td>
<td>Not applicable</td>
</tr>
<tr>
<td>3. Fixing the sawblade</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>4. Holding the sawframe</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>5. Setting the saw angle</td>
<td>✗</td>
<td>Too high</td>
</tr>
<tr>
<td>6. Sawing with steady speed, and movement</td>
<td>✗</td>
<td>Jerking, twisting</td>
</tr>
<tr>
<td>B. Chiselling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Clamping the workpiece in the vice</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2. Selecting a suitable chisel</td>
<td>✗</td>
<td>Not applicable</td>
</tr>
<tr>
<td>3. Holding the chisel</td>
<td>✗</td>
<td>Not strong enough</td>
</tr>
<tr>
<td>4. Holding the hammer</td>
<td>✗</td>
<td>Too short</td>
</tr>
<tr>
<td>5. Keeping an eye on the target</td>
<td>✗</td>
<td>Not at the cutting edge</td>
</tr>
<tr>
<td>6. Setting the angle of the chisel</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>7. Using suitable chiselling force</td>
<td>✗</td>
<td>Not hard enough</td>
</tr>
</tbody>
</table>
Appendix B9 An example of a practical work on Layout work.

Exercise 3.

This exercise provides you a skill on layout.

A. Given:
1. A steel sheet 60 x 60 mm, all edges filed to smooth squared surfaces.
2. The drawing given below.

![Diagram of a steel sheet with dimensions and marks]

B. Task:
You should make a layout on the steel sheet according to the drawing.

C. Tools and equipment:
1. A Vernier highgauge.
2. A dye.
3. A V-block.
4. A pair of dividers
5. A steel rule.
6. A steel scriber

D. Conditions:
When you have completed your work, review your sequence of operations with the given sequence of operations on the next page and check the result of your layout with the given transparent plastic template.

Appendix B10 An example of the solution sheet given to exercise 3 on layout work.

Solutions to exercise 3.

Compare your work with the given transparent plastic template given, and follow the following sequence of operations.

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Paint a dye on the work surface and let it dry.</td>
</tr>
<tr>
<td>2</td>
<td>Place the work piece vertically against the V-block.</td>
</tr>
<tr>
<td>3</td>
<td>Set the vernier highgauge at 10 mm. and draw a line (1).</td>
</tr>
<tr>
<td>4</td>
<td>Set the vernier highgauge at 25 mm. and draw a line (2).</td>
</tr>
<tr>
<td>5</td>
<td>Set the vernier highgauge at 35 mm. and draw a line (3).</td>
</tr>
<tr>
<td>6</td>
<td>Turn the workpiece horizontally and place against the V-block.</td>
</tr>
<tr>
<td>7</td>
<td>Set the vernier highgauge at 15 mm. and draw a line (4).</td>
</tr>
<tr>
<td>8</td>
<td>Set the vernier highgauge at 20 mm. and draw a line (5).</td>
</tr>
<tr>
<td>9</td>
<td>Set the vernier highgauge at 25 mm. and draw lines (6, 7).</td>
</tr>
<tr>
<td>10</td>
<td>Lay the workpiece on the surface table and use a steel rule and a scriber to draw a line (8).</td>
</tr>
<tr>
<td>11</td>
<td>Set the dividers at 9 mm. by a steel rule and draw a circle (9).</td>
</tr>
</tbody>
</table>

The pictures below show the positions of the workpiece and the series of lines and circle to be drawn.

![Diagram of the positions of the workpiece and lines]

If you found any mistake(s), you are advised to correct that mistake or repeat the whole sequence from the beginning. Check your work with the transparent plastic template given.
Appendix B11 An example of a lesson plan used for one of the author's lessons.

LESSON PLAN
Topic Techniques in filing flat work
Time 60 min. Date 11 Sept. 80
Faculty of Technical Education
Class CC + ACC
Instructor Surat Thaitrong

I. Objectives
By the end of this lesson, students should be able to...
1. state the correct methods of holding a file for filing rough and smooth work.
2. select suitable filing directions and tell correct forces exerted upon the handle and the end of a file during filing flat work.
3. demonstrate rough, smooth and cross filing correctly in accordance with techniques suggested in the lesson.

II. Preknowledge
Students should have completed two lessons in clamping work and use of files in order to accomplish this lesson.

III. Performance

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<th>20</th>
<th>30</th>
<th>40</th>
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<th>60</th>
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Appendix C1 Table of specification for benchwork knowledge test. This test is designed to last 60 minutes.

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<tr>
<th>Taxonomy</th>
<th>Topic contents</th>
<th>Knowledge</th>
<th>Comprehension</th>
<th>Application</th>
<th>Analysis</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Measuring</td>
<td></td>
<td>A2</td>
<td>A1,B3,B16</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>1. Vernier Calipers</td>
<td></td>
<td>A3</td>
<td>A4,B10,C2</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>2. Micrometers</td>
<td></td>
<td>B2</td>
<td>A5,B11</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>3. Bevel protractors</td>
<td></td>
<td>B13</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>4. Dial indicators</td>
<td></td>
<td>B1</td>
<td>A6,B12,C3,C4</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>5. Squares</td>
<td></td>
<td>B1</td>
<td>C1</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>B. Clamping</td>
<td></td>
<td>A8</td>
<td>C5</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>C. Scribing</td>
<td></td>
<td>A14,A15,A17,B9</td>
<td>A16,B17</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>D. Use of Files</td>
<td></td>
<td>A13,B4</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>1. Features and selection</td>
<td></td>
<td>A5,B6,B7,B8,C8</td>
<td>A10,B14,C7</td>
<td>B5</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>2. Application</td>
<td></td>
<td>A11,A12</td>
<td></td>
<td></td>
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<td>2</td>
</tr>
<tr>
<td>E. Use of the Saw</td>
<td></td>
<td>C9,C10,C11</td>
<td>A7</td>
<td>C12</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>1. Features and selection</td>
<td></td>
<td>C6</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2. Application</td>
<td></td>
<td>B5,C13</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>3. Maintenance and safety</td>
<td></td>
<td>A18,A19,A20</td>
<td>C14,C15,C16</td>
<td></td>
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Appendix C2 Table of specification for technical drawing test. This test is prepared for 60 minutes.

<table>
<thead>
<tr>
<th>Taxonomy</th>
<th>Knowledge</th>
<th>Comprehension</th>
<th>Application</th>
<th>Analysis</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>1. Isometric views</td>
<td></td>
<td>A1, A2</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>2. Projection views</td>
<td>A3</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>3. Assembly views</td>
<td>B3, B4</td>
<td></td>
<td></td>
<td>B5, B6</td>
<td>1</td>
</tr>
<tr>
<td>4. Materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>5. Machine parts</td>
<td>B1, B2</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>6. Tolerances</td>
<td>B7a, B7b,</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>B7c</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Planning</td>
<td></td>
<td>B8</td>
<td>B9</td>
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</table>
A. Please complete all the following test items. Insert ✓ on the blank in front of the items which you think is correct, and X for those you think are incorrect.

1. 'Cumulative error' in measuring results from the continuous measuring method.

2. The correct measuring method used in making layout work is characterised by the measurements having the same reference plane.

3. A vernier caliper is an expensive instrument. Therefore you should keep it in your trouser pocket.

4. If you use a vernier caliper which has been left in the sun for a long time, your reading on the vernier will be smaller than the actual size of an external work.

5. To prevent the movement of the micrometer thimble, the spindle must be moved against the anvil when the micrometer is to be stored.

6. It is a correct procedure to use 'anti-rust oil' on the stem of a dial indicator.

7. It is quite likely that a new sawblade will be broken when it is used in an old saw slot.

8. A pair of smooth jaw plates are used perfectly for clamping cylindrical works.

9. The convex side of flat file is used for reducing high spot areas on filed work.

10. The force exerted on the handle of a file at the beginning of the cutting stroke should be greater than that on the end.

11. It is a good practice to apply 'anti-rust oil' on the faces of a file.

12. One safety precaution is always to use a file with handle.

13. The correct type of file for steel work is a single-cut file.

14. After use scribers and dividers always must be oiled.

15. The point angle of a prick punch is smaller than that of a centre punch.

16. One reason for punching a series of dots on a scribed line is to indicate the minimum allowance for the work.

17. It is a good protective measure to put a cork on the end of the unused side of a scriber.

18. To prevent a danger from flying waste when using a chisel a piece of cardboard should be placed in front of the direction of the chisel.

19. When hammering a chisel the operator should keep his eye on the rear end of the chisel.

20. Resharpening the cutting edge of a chisel to a red hot will increase the hardness of the chisel.
B. Please insert the correct answer to the blank.

1. In checking the surface level of a work place the straight edge should be placed on three different directions.
   a) The first direction is _______
   b) The second direction is _______
   c) The third direction is _______

2. Indicate the function of the two parts of the micrometer shown in the diagram on the right.
   a) The function of part 1 is _______
   b) The function of part 2 is _______

3. From the drawing on the right
   \[ D = 30 \pm 0.2, \quad d = 15 \pm 0.2 \quad \text{and} \quad C = 30 \pm 0.2. \]
   The maximum allowance for \( a \) is _______ mm.

4. Please state the function of both sides of a flat file.
   a) The smooth face is used for _______
   b) The single-cut face is used for _______

5. From the position of the file in the diagram on the right, please draw arrows indicating the directions of the forces necessary to file the face of the work at this particular position.

6. The longitudinal filing direction is suitable for filing a ______ surface.

7. In rough filing, the ______ of the right hand must be placed along the centre line of the file.

8. The correct position for the feet in longitudinal filing is: the left foot is at _______ degrees and the right foot is at _______ degrees to the direction of filing.

9. The bent-end of the scriber is used for _______

10. Please read the following settings on the vernier caliper
    \[ 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \quad 8 \quad 9 \quad 10 \]
    a) Reading = ______ mm.  
    b) Reading = ______ mm.

11. Please read the following settings on the micrometer.
    \[ 0 \quad 5 \quad 10 \quad 15 \quad 20 \quad 25 \quad 30 \quad 35 \quad 40 \quad 45 \]
    a) Reading = ______ mm.  
    b) Reading = ______ mm.

12. Please read the following settings on the dial indicator.
    \[ 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \quad 8 \quad 9 \]
    a) Reading = ______ mm.  
    b) Reading = ______ mm.
13. Please read the following setting of the Universal level protractor.

   a) Reading = _____ degrees   b) Reading = _____ degrees

14. For each of the filing tasks shown on the left, please indicate which the type of file is suitable.

   Work  Type of a file
   a) ____
   b) ____
   c) ____
   d) ____

15. For each of the tasks requiring the use of a chisel shown in the diagrams indicate the correct chisel and cutting angle.

   Work  Chisel  Cutting angle
   a) St. 37  1a)  2a) 
   b) Al.  1b)  2b) 

16. For each of the measurements of quality shown by the diagrams on the left, indicate the correct instrument.

   Work  Measuring instruments
   a) Right angle  1) 
   b) Parallel  2) 
   c) Surface texture  3) 
   d) Right angle  4) 

Brass
St. 37
Al.
17. From the following descriptions of operations, indicate a suitable scribing tool/equipment for each scribing operation.

**Scribing Operation** | **Tools/equipment**
--- | ---

a) Drawing a 250mm. diameter on a piece of steel

b) Drawing parallel lines on a piece of aluminium placed against the V-block

c) Determining the centre of a round bar placed on V-block.

d) Making a series of dots on lines scribed on a steel plate.

e) Drawing a 5mm. circle on a sheet of aluminium.

C. Please indicate the correct answer to each test item by placing a X in front of it.

1. Which statement is correct?

   a) A square can be used for checking the surface level of a piece of work.

   b) While checking the squareness of a work piece, the square must be tilted at 45°.

   c) To protect rust on a square, the 'anti-rust oil' must be used.

   d) To maintain it in good condition, a square should be polished with sand paper.

2. A cause of damage to the measuring jaws of a vernier caliper is...

   a) the frequent use on cast iron work.

   b) rubbing against work surface.

   c) too great a measuring pressure.

   d) rubbing the vernier with greasy hands.

3. Why should the stem of a dial indicator be moved up about 2mm. when it is being used for comparative measurement?

   a) Because it is the position for constant measuring pressure.

   b) To compensate for 'backlash' of the mechanism.

   c) Because it will be possible to measure smaller pieces of work.

   d) Because it is the position with the lightest measuring force.

4. What equipment is used for setting up the scale on a dial indicator?

   a) Slip gauges

   b) Feeler gauge

   c) Steel rule

   d) Inside micrometer.

5. Which type of hammer is suitable for driving a steel workpiece sat firmly on parallel bars in a vice?

   a) Aluminium hammer

   b) Wooden hammer

   c) Rubber hammer

   d) Steel hammer

6. Which picture represents the correct shape of a hammer?

   - [Picture a]
   - [Picture b]
   - [Picture c]
   - [Picture d]

7. It is quite common to get a tilted or damaged edge at the end of the round bar work. This is so because...

   a) The operator tends to file more strokes at the outer edge.

   b) The cutting teeth at the outer edge of a file are usually sharper than those at the inner side.

   c) The cutting pressure at the outer edge of a file is greater than that at the inner side.

   d) The force on the handle of a file is greater than that on the end.
5. If a workpiece must be held in the position shown in the right hand picture, the operator should:
   a) apply higher clamping force than usual.
   b) insert a piece of steel of equal size to the workpiece in the other end of the vice.
   c) change the clamping jaws to cross face ones.

Test on the use of the chisel

1. What are the types of work shown in the pictures?
   a) This type is called
   b) This type is called

2. From the pictures below, please identify the correct type of chisel and state the correct cutting angle of that chisel.

Chiselling works

   1a) Type of chisel
   1b) Cutting angle

   2a) Type of chisel
   2b) Cutting angle

   3a) Type of chisel
   3b) Cutting angle

   4a) Type of chisel
   4b) Cutting angle

3. In the picture given on the right there is one item of equipment missing. Name the missing item.

4. In the first round of making chisel traces on a scribed line with a flat cold chisel, it is a good practice for the operator to hold the chisel at an angle to the direction of chiseling. =True/False =

5. When using a chisel your eyes should be directed at the cutting edge of the chisel. =True/False =

6. If the chiselling angle is too great during chiselling, the depth of cut in the workpiece will be decreased/increased =.

7. The correct method of holding a 100mm long chisel is to hold it with the _______ fingers.

8. To prevent flying waste material from hitting other operators you should place _______ in front of direction of the chisel.

9. Which picture below shows the correct method of wedging the head of a hammer?

   a) 
   b) wedge
   c) 
   d)

Test on the use of the saw

1. Sight clearance means

2. Comparing an old and a new saw blade of the same type and size, will reveal that the sight clearance of a new saw blade is _______ than that of the old one.
3. The pictures below show the size, shape and materials of items to be sawn. State a correct number of teeth per 25mm. of the saw blade to be used for each.

Brass 30 St. 37 37 x 1 C 100
a) Teeth/25 mm.  b) Teeth/25 mm.  c) Teeth/25 mm.

4. The correct method of sawing a thin-wall tube is to turn the tube in a clockwise/anti-clockwise direction after each sawing.

5. When starting a cut in a flat workpiece the saw should be set at an angle of _____ degrees.

6. Match the correct saw given on the pictures to the work shown on the left hand pictures.

7. If the tension on a saw blade is too low, the sawing trace is liable to wander. True/False =

8. It is good practice to lubricate a saw if it is to be used for cutting a long thick workpiece. True/False =

9. After use the tension on the saw blade should be reduced in order to reduce _______ on the saw blade as well as on the frame of the saw.

______
Appendix C

The sample of the test of Technical drawing.

Part 1. From the isometric view given in frame 1, identify two identical isometrics of this object in frames a to f.

1. The first identical is ___________
2. The second identical is ___________

Part 2. From the assembly view of a clamping mechanism, please answer the following questions:
1. Part no. 10 is 5m6x20 DIN 7. What is meant by the codes '5m6x20'?
2. Part no. 12 is a washer 8.4 DIN 125. What is meant by '8.4'? 
3. The material of part no. 8 is st 50 K. What is this material? 
4. The material of part no. 12 is S S. What is it? 
5. Sketch freehand the front view and the top view of part no. 1. 
6. Sketch freehand the front view and the side view of part no. 2.
7. From the front view and the side view of part no. 3 given above, answer the following:
   a. The length is $60_{-0.3}$. What is the maximum allowance of this length?
   b. The thickness is given by $12_{-0.1}$. What do $f$ and $g$ stand for?
   c. The lower right hand end of the front view is given by $5\times5^\circ$. What does this mean?

8. Suppose the stock in the picture on the right is to be filed to required size and shape. What would be the correct sequence of filing? Given side 1 and 2 are filed already.

9. Part no. 3 given above is to be manufactured from a smooth filed piece of work. The first stage, however, is to cut the L-shaped piece out from the given filed workpiece. Please complete the operation plan for cutting the L-shape from the given filed workpiece. Below is the first step of the operation.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Items</th>
<th>Part No.</th>
<th>Material</th>
<th>Stock</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Clamping Mechanism</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Operations</th>
<th>Tools / equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Layout the L-shape</td>
<td>Vernier highgauge</td>
</tr>
</tbody>
</table>
APPENDIX C 5 Sample of post-tests of the 11 study unit programmed texts.

Direction: Please read all the test items once thoroughly before starting your answers. Answer all the test items and write your answer on the answer sheet.

Test on Universal Bevel protractors

1. The measuring range of the universal bevel protractor shown in picture on the right is ______ degrees.

2. The accuracy of the universal protractor, shown in the picture is ______ minutes.

3. Please read the settings of the universal bevel protractors given in item 2.

4. If the reading on the protractor, shown in the picture on the right is 54 degrees what is the size of angle θ?

5. After use a protractor must be cleaned with cloth and have anti-rust oil applied. = True/False

Test on the measurement surface texture, surface level and squareness

1. Please interpret the symbols of quality specification given on the drawing on the right.
   a) Ra 1 μ means ______
   b) W means ______
   c) ~ means ______

2. Please write down two possible measuring instruments for checking the level of flatwork.
   a) ______
   b) ______

3. The measuring instrument used for checking the smoothness of surfaces is called ______

4. Indicate two possible methods of estimating the surface texture with surface texture gauges.
   a) ______
   b) ______

5. It is a rule of checking the surface level of a workpiece that the surface level must be checked in three directions, please name these directions.
   a) ______
   b) ______
   c) ______

6. One reason for checking the surface level in three directions is that each check will be based upon line contact. = True/False

7. The picture on the right shows a square being used to check the squareness of a workpiece. Why is this position wrong?
8. To maintain it in good condition, the square should always be polished with sand paper after use. = True/False =

9. Identify the faults in the workpiece shown in the picture on the right.

10. Identify the faults in the workpiece as shown in the picture on the right.

**Test on measuring squareness and parallel**

1. =True/False = The accuracy obtained in checking squareness will be diminished if the base surface of the workpiece is rough.

2. =True/False = Using a square to check the squareness of a workpiece will reveal both the squareness and the surface level of the workpiece.

3. Indicate why the square shown in the picture on the right is in the wrong position to check the squareness of the workpiece.

4. Write down the correct order of measuring the squareness of the sides of the tenon as shown on the right, (a vernier caliper and a square may be used).

5. In checking or measuring the parallel of the shaded surface to the base at the back the measuring instruments used in this case is _______ or _______.

6. Indicate with dark spots on the shaded surface shown in item 5, the measuring positions with the tools used.

---

**Test on Vernier Calipers**

1. Read the following settings of a vernier caliper 1/20mm.

   a) Reading = _____ mm.
   b) Reading = _____ mm.

2. If the inside measuring jaws of a vernier caliper are not parallel to the hole, the reading on the vernier will be _______ smaller/larger = than the actual diameter of the hole.

3. Removing the vernier caliper from the workpiece to read the scale, will cause _______ on the measuring jaws of the vernier caliper.

4. If the measuring force on the vernier caliper is too great when measuring the slot of a workpiece, the reading on the vernier scale will be _______ smaller/larger = than the actual size of the slot.

5. If the reading of the slot of a workpiece is bigger than the given tolerance, this workpiece must be ...
   a) accepted
   b) corrected
   c) rejected

**Test on Dial Indicator**

1. The measuring accuracy of a dial indicator is _______ mm.

2. If the long hand of the dial indicator is moving in a clockwise direction, its stem will move inwards. = True/False =

3. If the reading on a dial indicator is 5.4 mm, its long hand will point to _____ and the short hand to _____ of their respective scales.
4. If a dial indicator is set up in inclined position to the surface being measured, the deviation of the reading on the dial indicator will be _____ than the actual size of the workpiece.

5. The reason for setting the scale of a dial indicator to 2mm when comparing the sizes of workpieces is to make smaller readings possible = True/False =

Test on scribing

1. Please give the correct definition of each of the following items:
   a) Continuous measuring __________________________
   b) Absolute measuring ____________________________
   c) Parallax error _________________________________
   d) Cumulative error ______________________________

2. Holding a scribe in inclined position will make it possible for the pointed end of the scribe to touch the lower edge of the steel rule. = True/False =

3. The correct measuring method of scribing is continuous measuring. = True/False =

4. Why is it necessary to punch a series of tiny marks on scribed lines of a workpiece prior to forming?

5. Why is it unnecessary to paint blue dye on cast iron before scribing?

6. The correct method in scribing lines with a vernier highgauge is by drawing the scribe in its sidewise position. = True/False =

Test on files

1. Write down the name of the following files.
   a) _____ file
   b) _____ file
   c) _____ file

2. Write down the materials which should be filed with the following types of cut of files. Materials are: cast iron, copper, bronze, tin.
   a) material ______
   b) material ______
   c) material ______
   d) material ______

3. Please match the correct type of cut of files to the surface symbols in the drawing.
   a) ______
   b) ______
   c) ______

4. Which picture is correct in filing the shoulder of a workpiece?
   a) ______
   b) ______
5. Which drill hole is correct for the handle of a file?
   a) A hole as wide as the middle of the tang of the file.
   b) A hole as wide as the end of the tang of the file.
   c) A three-step hole with widths the same as three different positions along the tang of the file.

6. Which is the correct procedure for cleaning a file?
   a) Brushing the file along its length with a steel brush.
   b) Brushing the file along the slots of cutting teeth with a steel brush.
   c) Scraping clogged waste on the cutting teeth of the file with a scriber.

**Test on Filing**

1. In rough filing, the ____ finger of the right hand should be on the handle of the file, and the ____ of the left hand on the end.

2. A sloping edge nearest the operator on a filed workpiece is normally due to the force exerted at the end of the file being ____ than that on the handle.

3. To maintain the level of the file during draw-filing, both hands must hold the body of the file close together/apart from each other.

4. In cross filing the left foot of the operator should be at ____ degree, and the right foot at ____ degree to the direction of filing.

5. In smooth filing, the operator should lean his body forward in harmony with the movement of the hands during the cutting stroke. True/False =

6. During filing at the outer edge of a workpiece, the operator should twist the handle of the file = towards/away from = the workpiece.

7. Transverse filing is used for = rough filing/second filing/finish filing =.

**Test on clamping work**

1. The correct accessory to be used in clamping the round bar as shown in the picture on the right...
   a) V-notch jaws
   b) Cross face jaws
   c) A fibre jaw attachment.

2. Which is the incorrect statement about the liability of the workpiece held in the vice shown in the picture on the right?
   a) The workpiece is liable to bend if the clamping force is too great.
   b) The workpiece is liable to bend if it is filed to smaller size.
   c) The workpiece is liable to fall out due to insufficient clamping surfaces.

3. It is likely that during filing a workpiece held in the position shown in the picture in the right will...
   a) Slip downwards
   b) Vibrate
   c) Be bent or broken.

4. The jaw plate shown in the picture is used for...
   a) Rough flat work
   b) Smooth flat work
   c) Large area work
   d) Narrow area work.
8. For smooth filing on aluminium, one should use...
   a) a single-cut file       b) a double-cut file
   c) a curve-cut file       d) a rasp-cut file

9. The correct saw blade for St 37 is...
   a) 14 teeth per 25mm.     b) 22 teeth per 25mm.
   c) 32 teeth per 25mm.     d) 40 teeth per 25mm.

10. The correct saw blade for thin-walled tube Ø 22x2 is...
    a) 14 teeth per 25mm.     b) 22 teeth per 25mm.
     c) 32 teeth per 25mm.     d) 40 teeth per 25mm.

11. When beginning sawing, the saw should be...
    a) parallel to the work surface  b) tilted at 30° to work
    c) tilted at 45° to work surface  d) tilted at 60° to work

12. Which picture does show the method of sawing a thin-wall tube?

   a) [Diagram]       b) [Diagram]       c) [Diagram]       d) [Diagram]

13. What is the correct angle for a flat cold chisel as shown in the picture?
    a) 10°    b) 30°
    c) 45°    d) 60°

14. From the sketch what would happen if the operator continued to chisel the work in the same direction?
    a) The breakage of the cutting edge of a chisel
    b) Flying waste material
    c) A high notch at the end of the workpiece.
    d) The damage to the end of the workpiece.

15. The mushroom head at the end of a chisel must be ground off because...
    a) it will cause the hammer to slip.
    b) it will cause the hammer to bounce.
    c) it will hamper holding the chisel.
    d) the end of the chisel will tear off and cause damage.

16. For reasons of safety when using a chisel, you should wear...
    a) goggles       b) gloves
    c) a helmet      d) an apron
Appendix C6  An example of the basic workshop skill test, administered to the ACC students at the pre-system stage.

Task: Filing

Given: 1. A double-cut file 300 x 0
2. A double-cut file 250 x 3
3. A double-cut file 150 x 3
4. A single-cut file 300 x 0
5. A single-cut file 250 x 3
6. A single-cut file 150 x 3
7. A steel brush
8. A brush
9. A vernier caliper
10. A square
11. A steel bar □ 20 x 50

Required: You should examine the tools, equipment and piece of steel provided on the bench, and a drawing given below.

You are required to file one end of the steel down by 1 mm. and to a medium finish flat surface by following these steps.

1. Clamping the steel in a vice.
2. Select a suitable file.
3. File the steel to medium finish flat surface.
4. Clean the face of the file.
5. Clean the filed surface.
6. Continue filing until finished.

When you have finished filing, then clean the vice and the other tools/equipment and put them back on the bench in an orderly way. If you have understood these instruments you may now start.
Appendix C7  The workshop test sheet used on the post-study unit stage.

Benchwork Practice Course  Studt unit-stage post-test
K.M.I.T. / North Bangkok Campus  September 80 - SUR

Introduction  You will be given a piece of steel of 51 x 60 x 20 mm. in size, and an assessment sheet for grading your finished work.

Tasks  You are required to complete the following tasks in accordance with standards to be met as given on the assessment sheet. You should be able to finish the work within 10 hours.

1. File the base.
2. File both right-hand and left-hand surfaces.
3. Make the layout of the circle and the top right-hand shoulder.
4. Saw the shoulder (do not file the sawed shoulder).
5. Measure your finished work and complete the assessment sheet, and return it to your supervisor.

Drawing

Material : St. 37  Stock : 51 x 60 x 20
Appendix C8  An example of the test sheet on the post-exercise unit stage.

Test: Post-exercise unit stage
Class: ___________
Name: ___________

Date: ________

Surat Thaitrong

Direction: This test is part of your workshop training. The work given here is in fact the 'Fixed Jaw', one main component of your small vice.

Task: In this test you are required to perform the following:

1. Plan your operation sheet stating the sequence of operations and tools to be used. You have 30 minutes for this.
2. Produce a workpiece according to standards given in the drawing shown below.
3. Grade your finished work in accordance with the details in the given grading sheet. You must finish tasks and 3 within 30 hours.

Given:
1. A sheet of paper for planning.
2. A stock □ 50 x 45 x 22, St 37.
3. A grading sheet.

Drawing:

Given dimensions and measurements for the workpiece.

---

421
Appendix C9  An example of the assessment form for grading student performance and the work done in the practice and exercise unit stage.

<table>
<thead>
<tr>
<th>Class</th>
<th>Project</th>
<th>Name of part</th>
<th>Student</th>
<th>Teacher</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Symbols:  
- X = Yes / suitable  
- I = Sufficient  
- 0 = No / insufficient

<table>
<thead>
<tr>
<th>Activities</th>
<th>Description</th>
<th>Grading scores</th>
<th>Possible scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>1. Was done accordingly to schedules.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Was done correctly, perfectly, safely.</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Finished</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workpiece</td>
<td>3. Was submitted in time.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Was highly qualified to standards.</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Consumed only one stock.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Was measured and graded correctly and completely.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Report</td>
<td>7. Was submitted in time.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8. Was highly qualified to criteria.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9. Was correct and complete.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
Appendix C 10 The workshop observation form which was proposed for using in the training.

<table>
<thead>
<tr>
<th>Observation Form B : Manual work operations. Reports point 2 of the assessment form.</th>
<th>Benchwork Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work No. _______ Student Class _______ Supervisor _______ Date ______________</td>
<td>Date ______________</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Max. Score</th>
<th>3</th>
<th>3</th>
<th>3</th>
<th>3</th>
<th>3</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note</td>
<td>Max. Score</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Graded (%)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Tapping</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Drilling</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Reaming</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Screwing</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Chiselling</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sawing</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Planing</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Chamfering</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Layout</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Measuring</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Check No.</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

X = Yes / sufficient
I = to some extent
O = No / insufficient

2. Performance was correct and complete
2.1 Tools and equipment used were suitable to particular works and materials.
2.2 Tools and equipment used or set up correctly, firmly and safely.
2.3 Operations were carried out correctly and proficiently.
2.4 Tools and equipment and work were in good conditions.
2.5 Tools / equipment and work were clean and placed in an orderly was on the bench.
2.6 Bench and floor were always kept clean and tidy.
2.7 A safety guard was used and set up correctly when necessary.
Appendix C11  An example of the observation checklists used in testing basic workshop skills of the ACC students at the pre-system stage.

Task : Filing
Student Grich __________________________ Calss ACC ______________
Observer Anan __________________________ Date 7 Sept.80

<table>
<thead>
<tr>
<th>Activity</th>
<th>Performance (✓/X)</th>
<th>Faults</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Clamping a steel in the vice</td>
<td>X</td>
<td>not in the middle of the vice, too low.</td>
</tr>
<tr>
<td>2. Selecting a suitable file</td>
<td>X</td>
<td>at first used too small a file</td>
</tr>
<tr>
<td>3. Holding a file</td>
<td>X</td>
<td>the thumb was not along the middle line of the file handle.</td>
</tr>
<tr>
<td>4. Standing with feet in correct position</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>5. Filing the steel in the correct direction</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>6. Filing the steel at the right speed</td>
<td>X</td>
<td>too fast</td>
</tr>
<tr>
<td>7. Cleaning the filed surface with a brush</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>8. Cleaning the face of the file</td>
<td>X</td>
<td>not alone the cutting groove.</td>
</tr>
<tr>
<td>9. Quality of the filed surface</td>
<td>X1O</td>
<td>Incomplete</td>
</tr>
</tbody>
</table>

Note :  
X = + 0.2 (gap)
I = more than 0.2 to 0.4 (gap)
0 = more than 0.4 (gap)
### Assessment Sheet Example

**Student** Chardchai Srisanya, **class** ACC, **started** 14.15 **Date** 20 Sept. 80

**Teacher** Surat Thaitrong, **finished** 12.15 **Date** 24 Sept. 80

**Direction** If you have finished your work, please measure your work and complete this assessment form and return it to your supervisor.

<table>
<thead>
<tr>
<th>No.</th>
<th>List</th>
<th>Obtained</th>
<th>Grade</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Surface level of the base 0.2 (gap)</td>
<td>good</td>
<td>X</td>
<td>12 12</td>
</tr>
<tr>
<td>2</td>
<td>Surface texture of the base 1.6 μ</td>
<td>good</td>
<td>X</td>
<td>12 12</td>
</tr>
<tr>
<td>3</td>
<td>Surface level of the left-hand surface 0.2 (gap)</td>
<td>good</td>
<td>X</td>
<td>12 12</td>
</tr>
<tr>
<td>4</td>
<td>Surface texture of the left-hand surface 1.6 μ</td>
<td>good</td>
<td>X</td>
<td>12 12</td>
</tr>
<tr>
<td>5</td>
<td>Squareness of the left-hand surface to the base 0.1 (gap)</td>
<td>good</td>
<td>X</td>
<td>12 12</td>
</tr>
<tr>
<td>6</td>
<td>Surface level of the right-hand surface 0.2 (gap)</td>
<td>fair</td>
<td>X</td>
<td>12 12</td>
</tr>
<tr>
<td>7</td>
<td>Surface texture of the right-hand surface 1.6 μ</td>
<td>good</td>
<td>X</td>
<td>12 12</td>
</tr>
<tr>
<td>8</td>
<td>Squareness of the right-hand surface to the base 0.1 (gap)</td>
<td>good</td>
<td>X</td>
<td>12 12</td>
</tr>
<tr>
<td>9</td>
<td>Width of the base 50 ± 0.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>Scribed lines were complete and accurate to 0.1</td>
<td>fair</td>
<td>I</td>
<td>2 3</td>
</tr>
<tr>
<td>11</td>
<td>Punched marks were completed and accurate to 0.2</td>
<td>good</td>
<td>X</td>
<td>3 3</td>
</tr>
<tr>
<td>12</td>
<td>Sawing texture of the longer surface</td>
<td>good</td>
<td>X</td>
<td>3 3</td>
</tr>
<tr>
<td>13</td>
<td>Sawing texture of the shorter surface</td>
<td>fair</td>
<td>X</td>
<td>3 3</td>
</tr>
<tr>
<td>14</td>
<td>Sawing dimension at 25 -1.0</td>
<td>poor</td>
<td>I</td>
<td>2 3</td>
</tr>
<tr>
<td>15</td>
<td>Sawing dimension at 10 -1.0</td>
<td>poor</td>
<td>I</td>
<td>2 3</td>
</tr>
</tbody>
</table>

**Total** 111 126

**Total percentage obtained** 88%

**Legend**

- X = Obtained measure is within the tolerance (full marks)
- I = Obtained measure is less than 2 times outside the tolerance \( \frac{2}{3} \) mark.
- O = Obtained measure is more than 2 times outside the tolerance \( \frac{1}{3} \) mark.

*Completed by the student
**Completed by the supervisor (researcher)
+ This item was cancelled
Direction: The followings are a list of mistakes which students often make during their operations. Mark ✓ if the mistake is not made and X if it is.

<table>
<thead>
<tr>
<th>Description</th>
<th>Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Measuring instrument not on the cloth</td>
<td></td>
</tr>
<tr>
<td>2. Measuring instrument near cutting chips</td>
<td></td>
</tr>
<tr>
<td>3. Tools placed not in grader</td>
<td></td>
</tr>
<tr>
<td>4. Bench and floor are dirty</td>
<td></td>
</tr>
<tr>
<td>B. Filing</td>
<td></td>
</tr>
<tr>
<td>1. Work is not clamped properly</td>
<td></td>
</tr>
<tr>
<td>2. Incorrect use of clamping jaws</td>
<td></td>
</tr>
<tr>
<td>3. Incorrect holding of the file</td>
<td></td>
</tr>
<tr>
<td>4. Incorrect movement of hands, arms</td>
<td></td>
</tr>
<tr>
<td>5. Incorrect position of feet</td>
<td></td>
</tr>
<tr>
<td>6. Incorrect use of the file</td>
<td></td>
</tr>
<tr>
<td>7. Incorrect use of a steel brush</td>
<td></td>
</tr>
<tr>
<td>8. Rubbing the work with bare hand</td>
<td></td>
</tr>
<tr>
<td>C. Measuring</td>
<td></td>
</tr>
<tr>
<td>1. Measuring work in the vice</td>
<td></td>
</tr>
<tr>
<td>2. Incorrect use of a square</td>
<td></td>
</tr>
<tr>
<td>3. Incorrect use of a vernier caliper</td>
<td></td>
</tr>
<tr>
<td>D. Scribing</td>
<td></td>
</tr>
<tr>
<td>1. Incorrect holding of a work</td>
<td></td>
</tr>
<tr>
<td>2. Incorrect use of a scriber</td>
<td></td>
</tr>
<tr>
<td>3. Incorrect use of a vernier highgauge</td>
<td></td>
</tr>
<tr>
<td>E. Sawing</td>
<td></td>
</tr>
<tr>
<td>1. Work is not clamped properly</td>
<td></td>
</tr>
<tr>
<td>2. Incorrect holding of the saw</td>
<td></td>
</tr>
<tr>
<td>3. Incorrect sawing speed</td>
<td></td>
</tr>
<tr>
<td>4. Incorrect sawing stroke</td>
<td></td>
</tr>
</tbody>
</table>

426
Appendix C14  An example of the grading sheet used in the post-exercise unit stage test.

<table>
<thead>
<tr>
<th>Work: Fixed Jaw</th>
<th>Start: Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>Finish: Date</td>
<td>Time</td>
</tr>
<tr>
<td>Name</td>
<td>Supervisor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Side</th>
<th>Descriptions</th>
<th>measurement</th>
<th>Score</th>
<th>Obt.</th>
<th>Full</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Surface level + 0.05</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surface finish 0.8 μ</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Surface level + 0.05</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Squareness, to side 1 + 0.05</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surface finish 0.8 μ</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Surface level + 0.05</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Squareness, to side 1 and 2 + 0.05</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surface finish 0.8 μ</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Surface level + 0.05</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Squareness, to side 1 and 2 + 0.05</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surface finish 0.8 μ</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Surface level + 0.05</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Squareness, to side 1 + 0.05</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In order to compare the learning effects for the lecture and self-study groups, I used an analysis of covariance of the post-test scores using the post-test scores as covarate.

The results of the analysis of series of squares and products and adjusted sums of squares are:

<table>
<thead>
<tr>
<th>Scores</th>
<th>Sums of squares and products</th>
<th>Adj. sum of squares</th>
<th>d.f</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\Sigma X^2$</td>
<td>$\Sigma XY$</td>
<td>$\Sigma Y^2$</td>
</tr>
<tr>
<td>1. Between groups</td>
<td>11.11</td>
<td>2.78</td>
<td>0.70</td>
</tr>
<tr>
<td>2. Within groups</td>
<td>73.78</td>
<td>14.11</td>
<td>30.95</td>
</tr>
<tr>
<td>3. Total</td>
<td>84.89</td>
<td>16.89</td>
<td>31.65</td>
</tr>
</tbody>
</table>

The unadjusted initial and final means of the two groups are:

$$
\bar{X}_1 = \frac{X_1}{N_1} = \frac{36}{18} = 2.0
$$

$$
\bar{X}_2 = \frac{X_2}{N_2} = \frac{56}{18} = 3.11
$$

$$
\bar{Y}_1 = \frac{Y_1}{N_1} = \frac{93}{18} = 5.16
$$

$$
\bar{Y}_2 = \frac{Y_2}{N_2} = \frac{98}{18} = 5.44
$$

The general mean of both groups on the initial test is:

$$
\bar{X} = \frac{\Sigma X}{N} = \frac{92}{36} = 2.56
$$

The initial mean differences from the general mean of both groups are:

$$
d_1 = \bar{X} - \bar{X}_1 = 2.56 - 2.0 = 0.56
$$

$$
d_2 = \bar{X} - \bar{X}_2 = 2.56 - 3.1 = -0.56
$$

The regression coefficient $b = \frac{\Sigma XY}{\Sigma X^2} = \frac{14.11}{73.78} = 0.19$

The adjusted final means of both groups are:

$$
\bar{Y}_1' = \bar{Y}_1 - (b \times d_1) = 5.16 - (0.19 \times 0.56) = 5.34
$$

$$
\bar{Y}_2' = \bar{Y}_2 - (b \times d_2) = 5.20 - (0.19 \times (-0.56)) = 5.27
$$

The estimated standard error for the difference of the two adjusted means is:

$$
S_d = \sqrt{\left(\frac{1}{N_1} + \frac{1}{N_2} + \frac{(X_1 - X_2)^2}{\Sigma X_w^2}\right) SS'_{w}} = \sqrt{\left(\frac{1}{18} + \frac{1}{18} + \frac{(2.0 - 3.1)^2}{73.78}\right) 28.25} = 0.31
$$

The $t$-test for the adjusted mean difference of the two groups is:

$$
t = \frac{\bar{Y}_1' - \bar{Y}_2'}{S_d} = \frac{5.34 - 5.27}{0.31} = 0.225 (34 \text{ d.f., } P < 0.05)
$$
Appendix D2 (a) Kolmogorov-Smirnov one sample test

I  Example

<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>Fair</th>
<th>Low</th>
<th>None</th>
<th>Sample size</th>
</tr>
</thead>
<tbody>
<tr>
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II  Procedure

1. The observed student responses are converted into cumulative frequencies which are then divided by the number of the sample size to obtain cumulative proportions (CPo).
2. A theoretical cumulative proportion (CPe) is also cumulated on the basis under the null hypothesis.
3. The observed cumulative proportion (CPo) is then compared with the theoretical proportion (CPe) to identify $|CPo - CPe|_{(max.)}$.
4. $|CPo - CPe|_{(max.)} = D$, which is then compared with the critical values of D in the Kolmogorov-Smirnov one sample test. If the obtained D value is larger than the value in the D table it is significant at that level.

Reference: This is followed the procedure shown in Cohen and Holliday, 1979; pp. 133-135.

1. See Cohen and Holliday, 1979; p.136
Appendix D2 (b) Kolmogorov-Smirnov two sample test

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II Procedure

1. Converted the frequency (F) in the response frequency to cumulative frequency (CF) by serially adding.

2. Estimate the cumulative frequency proportion (CP) by adding by the sample size and determine the absolute difference (C) between the cumulative proportions within each interval. Ignore minus signs.

3. Identify the largest of the differences D.

\[
D = \max |CP_1 - CP_2|
\]

4. Compute K

\[
K = D \sqrt{\frac{(n_1 + n_2)}{n_1 + n_2}}
\]

where \(n_1\) and \(n_2\) = number of students in the first and the second groups respectively.

5. Consult the critical value of K, if the obtained K is larger than the value in the K table it is significant at that level.

Appendix El Test scores of CC and ACC students on technical drawing and benchwork theory.

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| 13      | 5      | 4      | 6      | 7      | 9      | 24     | 43     | 47     | 53     | 55     |
| 14      | 5      | 19     | 15     | 14     | 14     | 30     | 48     | 54     | 54     | 58     |
| 15      | 9      | 6      | 12     | 17     | 16     | 35     | 57     | 65     | 64     | 60     |
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| 20      | 1      | 5      | 6      | 6      | 7      | 26     | 49     | 51     | 58     | 56     |

Note: 1 = Pre-system  
2 = Study unit stage  
3 = Practice unit stage +  
4 = Exercise unit stage  
5 = Post-course  
Consolidating unit stage
### Appendix E2  Student response plot on techniques in filing flat work.

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+ = correct response, 0 = incorrect response
Appendix E3  Student response plot in technical drawing, at the end of the training course.

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<thead>
<tr>
<th>Part 1</th>
<th>Part 2</th>
<th>(\sum X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 A2 A3</td>
<td>B1 B2 B3 B4 B5 B6 B7</td>
<td>B8 B9 Part 1 Part 2 Total</td>
</tr>
<tr>
<td>1. 1 0 1 1 1 2</td>
<td>1 0 0 0 0 1 2 1 0 0 0 0</td>
<td>6 4 10</td>
</tr>
<tr>
<td>2. 1 1 1 1 1 2</td>
<td>0 0 0 0 0 0 0 0 1 2 0</td>
<td>7 3 10</td>
</tr>
<tr>
<td>3. 1 1 1 1 1 2</td>
<td>0 0 0 0 0 0 0 1 0 1 1 0</td>
<td>8 3 11</td>
</tr>
<tr>
<td>4. 1 0 1 1 1 2</td>
<td>0 0 0 0 0 0 3 0 1 1 0 1 0</td>
<td>7 6 13</td>
</tr>
<tr>
<td>5. 0 0 1 1 1 2</td>
<td>0 0 1 0 0 2 4 1 0 1 4 0</td>
<td>6 12 18</td>
</tr>
<tr>
<td>6. 1 1 1 1 1 2</td>
<td>0 0 1 0 2 2 2 1 7 0 4 0</td>
<td>9 13 22</td>
</tr>
<tr>
<td>7. 0 0 1 1 2 2</td>
<td>0 0 1 0 0 3 2 1 1 0 4 0</td>
<td>6 12 19</td>
</tr>
<tr>
<td>8. 1 1 1 1 1 0</td>
<td>0 0 1 0 0 2 1 0 1 2 3</td>
<td>4 10 14</td>
</tr>
<tr>
<td>9. 1 1 1 1 1 2</td>
<td>1 1 1 6 2 1 0 1 4 0</td>
<td>9 21 30</td>
</tr>
<tr>
<td>10. 2 0 1 1 2 2</td>
<td>0 0 1 0 0 2 1 0 1 0 0</td>
<td>8 6 14</td>
</tr>
<tr>
<td>11. 1 1 1 1 1 1</td>
<td>0 0 1 0 0 0 0 0 0 4 0</td>
<td>9 25 34</td>
</tr>
<tr>
<td>12. 1 0 1 1 1 2</td>
<td>0 0 0 0 0 3 2 1 0 1 4 0</td>
<td>7 11 18</td>
</tr>
<tr>
<td>13. 1 1 1 1 1 2</td>
<td>0 0 0 0 0 2 2 2 0 1 1 4 0</td>
<td>8 12 19</td>
</tr>
<tr>
<td>14. 1 0 1 1 1 2</td>
<td>0 1 0 0 4 1 1 0 1 4 0</td>
<td>7 12 19</td>
</tr>
<tr>
<td>15. 1 1 1 1 1 2</td>
<td>0 0 0 0 0 0 2 1 0 0 4 0</td>
<td>8 7 15</td>
</tr>
<tr>
<td>16. 2 1 1 1 1 2</td>
<td>0 0 0 0 4 4 1 0 1 2 0</td>
<td>9 12 21</td>
</tr>
<tr>
<td>17. 0 1 1 1 1 2</td>
<td>0 0 0 0 4 2 0 0 1 1 0</td>
<td>9 8 17</td>
</tr>
<tr>
<td>18. 1 1 1 1 1 1</td>
<td>0 0 1 0 0 2 1 0 0 4 0</td>
<td>8 13 18</td>
</tr>
<tr>
<td>19. 1 1 1 1 1 1</td>
<td>0 0 1 0 0 2 2 0 0 4 0</td>
<td>6 9 15</td>
</tr>
<tr>
<td>20. 1 1 1 1 1 2</td>
<td>0 0 0 0 0 1 0 1 0 1 4 0</td>
<td>9 7 16</td>
</tr>
<tr>
<td>21. 2 1 1 1 1 2</td>
<td>0 1 0 0 3 4 1 1 1 4 3</td>
<td>9 18 27</td>
</tr>
<tr>
<td>22. 1 1 1 1 1 2</td>
<td>0 0 0 0 0 0 0 0 0 1 3 0</td>
<td>8 4 11</td>
</tr>
<tr>
<td>23. 1 1 1 1 2</td>
<td>0 0 0 0 0 0 0 2 1 0 2 0</td>
<td>8 8 16</td>
</tr>
<tr>
<td>24. 1 1 1 2</td>
<td>0 0 0 0 0 0 1 0 0 0 0 0</td>
<td>7 1 8</td>
</tr>
<tr>
<td>25. 2 1 1 1 2</td>
<td>0 1 1 0 4 2 1 0 1 4 3</td>
<td>9 17 26</td>
</tr>
<tr>
<td>26. 0 1 1 1 2</td>
<td>0 1 0 0 5 2 1 0 1 4 1</td>
<td>8 15 23</td>
</tr>
<tr>
<td>27. 1 0 1 1 2</td>
<td>0 0 1 0 5 2 1 0 1 1 4</td>
<td>8 15 23</td>
</tr>
<tr>
<td>28. 1 1 1 1 1 2</td>
<td>1 0 0 0 1 1 1 1 1 4 3</td>
<td>8 13 21</td>
</tr>
<tr>
<td>29. 1 1 1 1 1 2</td>
<td>0 0 1 0 5 4 1 1 1 4 3</td>
<td>7 16 23</td>
</tr>
<tr>
<td>30. 1 1 1 1 1 2</td>
<td>0 1 1 0 2 0 1 1 1 2 0</td>
<td>7 9 16</td>
</tr>
<tr>
<td>31. 1 1 1 1 2</td>
<td>1 0 0 0 2 2 1 0 1 4 3</td>
<td>8 14 22</td>
</tr>
<tr>
<td>32. 1 1 1 1 2</td>
<td>0 1 0 0 4 2 0 0 1 4 3</td>
<td>8 16 24</td>
</tr>
<tr>
<td>33. 1 1 1 1 2</td>
<td>0 1 0 0 8 2 1 0 1 1 0</td>
<td>8 14 22</td>
</tr>
<tr>
<td>34. 1 1 1 1 1</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>5 5 10</td>
</tr>
<tr>
<td>35. 2 1 1 1 1</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>7 0 7</td>
</tr>
<tr>
<td>36. 1 1 1 1 2</td>
<td>0 0 0 0 0 0 0 1 0 1 4 3</td>
<td>8 9 17</td>
</tr>
<tr>
<td>37. 1 1 1 1 2</td>
<td>0 0 0 0 0 0 0 1 0 1 4 3</td>
<td>7 7 14</td>
</tr>
<tr>
<td>38. 1 1 1 1 2</td>
<td>0 0 0 0 0 0 0 1 0 1 4 0</td>
<td>7 7 14</td>
</tr>
</tbody>
</table>

| \(\sum X\) | 42 27 33 34 59 60 |
| \(\bar{X}\) | 1.2 0.79 0.97 1.0 1.7 1.8 |
| \(\bar{X}/K\) | 0.6 0.79 0.97 1.0 0.83 0.9 |

*Absent* + ill  \(N = 34\) students  \(K = \) maximum possible mark

433
Appendix E4  Response distribution in student attitudes at the pre-system stage.

Part A: Students' previous workshop experiences

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Class</th>
<th>Percentage of response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>How well did you know about grading on finished works?</td>
<td>a</td>
<td>30 40 30 0 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>6 38 50 6 0</td>
</tr>
<tr>
<td>2.</td>
<td>How well did you know how the final grade was done?</td>
<td>a</td>
<td>20 30 50 0 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>6 44 38 12 0</td>
</tr>
<tr>
<td>3.</td>
<td>How well did you know about aims of the previous workshop course?</td>
<td>a</td>
<td>0 20 60 20 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>12 12 63 6 6</td>
</tr>
<tr>
<td>4.</td>
<td>How well did you know about aims of the report writing?</td>
<td>a</td>
<td>10 20 50 0 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>6 12 63 19 0</td>
</tr>
<tr>
<td>5.</td>
<td>How well could you gauge your own weaknesses &amp; strengths in workshop practice?</td>
<td>a</td>
<td>0 10 40 40 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>0 12 38 50 0</td>
</tr>
<tr>
<td>6.</td>
<td>How well did you know about principles or techniques in selection tools suitable for producing workpieces?</td>
<td>a</td>
<td>0 30 70 0 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>0 38 44 19 0</td>
</tr>
<tr>
<td>7.</td>
<td>How well did you know about working techniques of your workshop operations?</td>
<td>a</td>
<td>0 20 70 10 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>0 38 44 19 0</td>
</tr>
<tr>
<td>8.</td>
<td>How well did you enjoy your workshop practice?</td>
<td>a</td>
<td>0 0 70 30 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>0 6 80 38 6</td>
</tr>
<tr>
<td>9.</td>
<td>How did you like report writing?</td>
<td>a</td>
<td>10 10 60 0 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>12 44 38 6 0</td>
</tr>
<tr>
<td>10.</td>
<td>How did you like working competitively with friends?</td>
<td>a</td>
<td>0 40 50 0 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>19 12 44 25 0</td>
</tr>
<tr>
<td>11.</td>
<td>How often did you work overtime?</td>
<td>a</td>
<td>20 50 20 10 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>25 63 12 0 0</td>
</tr>
<tr>
<td>12.</td>
<td>How often did you get help from or exchange ideas with friends during practicing?</td>
<td>a</td>
<td>10 10 70 10 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>6 19 44 31 0</td>
</tr>
</tbody>
</table>

cont'd ......
Appendix E4 (cont'd)

Part B: Students' expectation of the benchwork practice course

1 = A or nothing  
2 = B or little  
3 = C or moderate  
4 = D or much  
5 = For very much

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Class</th>
<th>Percentage of response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What final grade would you expect in this course?</td>
<td>a</td>
<td>40 60 0 0 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>25 69 6 0 0</td>
</tr>
<tr>
<td>2</td>
<td>What is your expectation of your own achievement in planning sequence of operations?</td>
<td>a</td>
<td>10 0 60 30 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>6 0 50 31 12</td>
</tr>
<tr>
<td>3</td>
<td>How much knowledge do your expect from workshop theory?</td>
<td>a</td>
<td>0 10 20 70 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>0 0 19 69 12</td>
</tr>
<tr>
<td>4</td>
<td>What is your expectation of your own achievement in producing acceptable workpieces?</td>
<td>a</td>
<td>0 0 90 10 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>0 0 94 6 0</td>
</tr>
<tr>
<td>5</td>
<td>What is your expectation of your own achievement in solving working problems in producing workpieces?</td>
<td>a</td>
<td>0 0 90 10 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>0 0 94 6 0</td>
</tr>
<tr>
<td>6</td>
<td>To what extent do you wish to have friends working with you?</td>
<td>a</td>
<td>50 40 10 0 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>50 25 19 6 0</td>
</tr>
<tr>
<td>7</td>
<td>To what extent do you wish to be admired by the teacher?</td>
<td>a</td>
<td>10 40 40 10 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>25 19 38 12 6</td>
</tr>
</tbody>
</table>

Part C: Students' attitudes towards the new training system

1 = very interesting  
2 = interesting  
3 = not interesting  
4 = not interesting at all  
5 = no idea

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Class</th>
<th>Percentage of response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>As you would be producing a small vice, how interesting do you think this could be?</td>
<td>a</td>
<td>50 30 10 0 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>50 31 12 0 6</td>
</tr>
<tr>
<td>2</td>
<td>As you would be working through 5 successive stages in the new system, how interesting do you think this would be?</td>
<td>a</td>
<td>50 50 0 0 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>50 44 0 6 0</td>
</tr>
</tbody>
</table>

Cont'd ....
Appendix E4 (cont'd)

Part C: Students' attitudes towards the new training system

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Class</th>
<th>Percentage of response</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>One objective of this course is that you will be able to plan operation sequence; how interesting do you think this would be?</td>
<td></td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td>a) very interesting</td>
<td>70 30 0 0 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) not interesting at all</td>
<td>44 56 0 0 0</td>
<td></td>
</tr>
</tbody>
</table>

4. As the new system would be allowing you to choose your own sequence of topics, what do you think about this?

| a) It is very personal | 50 45 |
| b) It is a bother | 17 15 |
| c) Not sure on how to choose them correctly | 0 20 |
| d) It is interesting | 33 20 |
| e) Other opinion (please specify) | 0 0 |

5. As you would be studying a number of lessons on your own, what do you think about this?

| a) It is very personal | 36 27 |
| b) It is good to work closely with friends | 28 32 |
| c) It would be difficult to understand | 28 0 |
| d) I am afraid of being unable to keep up with friends | 8 0 |
| e) Other opinion (please specify) | 0 9 |

6. As the new system would be allowing good students to go on without waiting for others, what do you think about this?

| a) One does not waste one's time | 9 37 |
| b) One can learn much | 36 32 |
| c) Friends may feel a sense of rivalry | 27 16 |
| d) One may finish studying in less time | 0 0 |
| e) Other opinion (please specify) | 27 16 |
7. As you could be expected to achieve more than 60% of study unit test in order to move from the study unit stage to the next stage, what do you think about this?

<table>
<thead>
<tr>
<th></th>
<th>Percentage of response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CC</td>
</tr>
<tr>
<td>a) It is too hard</td>
<td>9</td>
</tr>
<tr>
<td>b) It is very challenging</td>
<td>9</td>
</tr>
<tr>
<td>c) It sets a good standard</td>
<td>55</td>
</tr>
<tr>
<td>d) It may cause disappointment</td>
<td>9</td>
</tr>
<tr>
<td>e) Other opinion (please specify)</td>
<td>18</td>
</tr>
</tbody>
</table>

8. As the new training system does require you to grade your own work, is it useful? Please give reasons.

<table>
<thead>
<tr>
<th></th>
<th>Percentage of response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CC</td>
</tr>
<tr>
<td>a) Useful</td>
<td>100</td>
</tr>
<tr>
<td>b) Not useful</td>
<td>0</td>
</tr>
</tbody>
</table>
Appendix E5 (a) Response distribution in student attitudes towards (Part A) the principles of the individualized learning.

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>Most Like</th>
<th>Like</th>
<th>Not Sure</th>
<th>Dislike</th>
<th>Most dislike</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Choosing your own programmed text.</td>
<td>11 (36.7)</td>
<td>18</td>
<td>1 (3.3)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. Choosing your own study places.</td>
<td>22 (73.3)</td>
<td>7</td>
<td>1 (3.3)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. Choosing your own study time.</td>
<td>17 (56.7)</td>
<td>11</td>
<td>2 (6.7)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4. Studying your own programmed texts.</td>
<td>8 (26.7)</td>
<td>16</td>
<td>5 (16.1)</td>
<td>1 (3.3)</td>
<td>0</td>
</tr>
<tr>
<td>5. Checking your own progress/weaknesses.</td>
<td>5 (16.7)</td>
<td>16</td>
<td>6 (20.0)</td>
<td>3 (10.0)</td>
<td>0</td>
</tr>
<tr>
<td>6. Skipping some sections of a programmed text which you already knew.</td>
<td>4 (13.3)</td>
<td>11</td>
<td>9 (30.0)</td>
<td>6 (20.0)</td>
<td>0</td>
</tr>
<tr>
<td>7. Progressing at your own pace without waiting for or keeping up with others.</td>
<td>4 (13.3)</td>
<td>12</td>
<td>9 (40.0)</td>
<td>2 (6.7)</td>
<td>3 (10.0)</td>
</tr>
<tr>
<td>8. Pursuing a programmed text until completing the stated learning objectives.</td>
<td>6 (20.0)</td>
<td>16</td>
<td>8 (53.3)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9. Choosing your own peers.</td>
<td>17 (56.7)</td>
<td>11</td>
<td>2 (36.7)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10. Reviewing your own programmed texts.</td>
<td>16 (53.3)</td>
<td>13</td>
<td>1 (36.7)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Appendix E5 (b) Response distribution in student perceptions into (Part B) the structure of the study unit programmed texts.

<table>
<thead>
<tr>
<th>COMPONENTS</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The given network diagram enables you to choose your own programmed texts.</td>
<td>7 (21.2)</td>
<td>21 (63.6)</td>
<td>5 (15.2)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>2. Good programmed texts must contain very detailed explanations.</td>
<td>2 (6.1)</td>
<td>8 (24.2)</td>
<td>10 (30.3)</td>
<td>11 (33.3)</td>
<td>2 (6.1)</td>
</tr>
<tr>
<td>3. Illustrations given in programmed texts facilitate your understanding of the contents.</td>
<td>18 (54.5)</td>
<td>14 (42.4)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1 (3.0)</td>
</tr>
<tr>
<td>4. Exercises given in programmed texts enhance your understanding of the contents.</td>
<td>16 (48.5)</td>
<td>16 (48.5)</td>
<td>0 (0)</td>
<td>1 (3.0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>5. Solutions given to exercises in programmed texts are not necessary.</td>
<td>1 (3.0)</td>
<td>3 (9.1)</td>
<td>7 (21.2)</td>
<td>11 (33.3)</td>
<td>11 (33.3)</td>
</tr>
<tr>
<td>6. Results from the post-test are useful indicators of your learning achievement.</td>
<td>6 (18.2)</td>
<td>22 (66.7)</td>
<td>5 (15.2)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>7. A programmed text should include a pre-test.</td>
<td>7 (21.2)</td>
<td>18 (54.5)</td>
<td>6 (18.2)</td>
<td>1 (3.0)</td>
<td>1 (3.0)</td>
</tr>
<tr>
<td>8. Pictorial sequence of operations in practical exercises facilitate your practice.</td>
<td>9 (27.3)</td>
<td>15 (45.5)</td>
<td>8 (24.2)</td>
<td>1 (3.0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>9. Pictorial illustrations of a completed work are useful for checking your own finished workpieces.</td>
<td>7 (21.2)</td>
<td>18 (50.5)</td>
<td>8 (24.2)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>10. Practical exercises given in each programmed text enhance your understanding of the preceding contents.</td>
<td>0 (0)</td>
<td>9 (27.3)</td>
<td>10 (30.3)</td>
<td>10 (30.3)</td>
<td>4 (12.1)</td>
</tr>
</tbody>
</table>
Appendix E6 Response distribution in student perceptions to activities and components of the new training system.

<table>
<thead>
<tr>
<th>Components/Consequences</th>
<th>Student response (%)</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SA   (1)</td>
<td>A     (2)</td>
</tr>
<tr>
<td>A. Objectives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Learning objectives could motivate your study.</td>
<td>a 2.3</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>b 2.0</td>
<td>30.8</td>
</tr>
<tr>
<td>2. The objectives reflect the contents testing on workshop knowledge.</td>
<td>a 2.8</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>b 1.9</td>
<td>33.3</td>
</tr>
<tr>
<td>3. Your learning would be more improved if objectives were always given.</td>
<td>a 2.1</td>
<td>16.7</td>
</tr>
<tr>
<td></td>
<td>b 2.5</td>
<td>15.4</td>
</tr>
<tr>
<td>B. Workshop knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Practiced workshop skills even without theory could generate high confidence.</td>
<td>a 2.5</td>
<td>16.7</td>
</tr>
<tr>
<td></td>
<td>b 3.9</td>
<td>15.4</td>
</tr>
<tr>
<td>5. It was a waste of time to study about the use of tools &amp; production processes.</td>
<td>a 2.9</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>b 4.2</td>
<td>0</td>
</tr>
<tr>
<td>6. Knowledge learned in study unit topics was not beneficial for solving workshop problems.</td>
<td>a 3.1</td>
<td>16.7</td>
</tr>
<tr>
<td></td>
<td>b 4.1</td>
<td>0</td>
</tr>
<tr>
<td>7. Your efficient working was dependent solely upon successive practice on actual production exercises.</td>
<td>a 2.5</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>b 3.7</td>
<td>0</td>
</tr>
<tr>
<td>8. Knowledge on workshop theory partly enhanced safety measures in working.</td>
<td>a 2.2</td>
<td>16.7</td>
</tr>
<tr>
<td></td>
<td>b 1.5</td>
<td>53.8</td>
</tr>
<tr>
<td>9. It was unnecessary to study workshop theory on the use of tools, equipment or production processes prior to actual workshop practice.</td>
<td>a 3.4</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>b 9.6</td>
<td>0</td>
</tr>
<tr>
<td>10. It was the knowledge learned from workshop theory that facilitated your workshop practice.</td>
<td>a 2.0</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>b 1.1</td>
<td>92.3</td>
</tr>
<tr>
<td>11. Practicing without prior knowledge of any workshop theory would be one main cause of erroneous working.</td>
<td>a 2.0</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>b 1.9</td>
<td>46.2</td>
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Appendix E6 (cont'd)

<table>
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<tr>
<th>Components/Consequences</th>
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<tr>
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<td><strong>SA</strong></td>
</tr>
<tr>
<td><strong>C. Learning/Training Facilitators</strong></td>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>12. Pictorial quizzes on working techniques as given in consolidating unit topics stage did not enhance your confidence in workshop practice.</td>
<td>a</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>3.6</td>
</tr>
<tr>
<td>13. Pictorial quizzes partly enhanced your correct use of tools &amp; equipment.</td>
<td>a</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>2.2</td>
</tr>
<tr>
<td>14. A series of questions leading to planning as given in practice unit exercises were useless &amp; a waste of time.</td>
<td>a</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>3.3</td>
</tr>
<tr>
<td>15. Questions leading to planning generally diminished your confidence.</td>
<td>a</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>3.1</td>
</tr>
<tr>
<td>16. Questions leading to planning facilitated your correct working.</td>
<td>a</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>1.8</td>
</tr>
<tr>
<td>17. Questions leading to planning were generally quite challenging.</td>
<td>a</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>1.9</td>
</tr>
<tr>
<td>18. Pictorial sequence of operations as given in practice unit exercise facilitated your correct working.</td>
<td>a</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>1.7</td>
</tr>
<tr>
<td>19. Pictorial sequence of operations did not enhance your knowledge in the planning of operation sequence.</td>
<td>a</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>3.8</td>
</tr>
<tr>
<td>20. It would be rather more difficult to work on workshop exercises if there was no pictorial sequence of operations.</td>
<td>a</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>2.0</td>
</tr>
<tr>
<td>21. Faults/remedies guides as given in both practice unit &amp; exercise unit exercises made you more aware of possible working errors.</td>
<td>a</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>1.8</td>
</tr>
<tr>
<td>22. Faults/remedies guides were generally not applicable to your work.</td>
<td>a</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>3.6</td>
</tr>
</tbody>
</table>
Components/Consequences

<table>
<thead>
<tr>
<th>Class</th>
<th>Student response (%)</th>
<th>Class</th>
<th>Student response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------</td>
<td>-------</td>
<td>----------------------</td>
</tr>
<tr>
<td>a</td>
<td>3.3</td>
<td>0</td>
<td>25.0</td>
</tr>
<tr>
<td>b</td>
<td>02.5</td>
<td>53.9</td>
<td>7.7</td>
</tr>
</tbody>
</table>

23. Faults/remedies guides diminished your confidence.

24. Faults/remedies guides enabled you to work on your own with less help from the teacher.

25. Pictorial illustrations of good & poor work did not enlighten you to good quality working.

D. Task enrichment

26. Competence in planning the sequence of operations was dependent on workshop practice only.

27. Activities on planning the sequence of operations were very time consuming.

28. Discussion on planning with the teacher did not enhance your understanding about it.

29. A list of quality measurement as given in the grading sheets facilitated your understanding in planning the sequence of operations.

30. Grading sheets were useless or redundant from the drawings.

31. The use of grading sheets challenged you to work harder.

32. Without grading sheets you would be quite uncertain about the quality of workpieces.

33. Measuring activity & using the grading sheets was very time consuming.

34. Your competence in measuring work was greatly improved due to grading activities.
### Components/Consequences

<table>
<thead>
<tr>
<th></th>
<th>Class</th>
<th>Student response (%)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SA</td>
<td>A</td>
<td>UD</td>
<td>D</td>
<td>SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35. You could hardly complete the grading of your finished work as the rules for grading were too complicated.</td>
<td>a 3.2</td>
<td>0 16.7 50.0 33.3 0</td>
<td>b 4.0</td>
<td>7.7 0 0 69.2 23.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36. The process of grading activity undermined your willingness to work.</td>
<td>a 2.7</td>
<td>8.3 33.3 41.7 16.7 0</td>
<td>b 4.1</td>
<td>0 0 15.4 61.5 23.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37. Your working competence was improved greatly as a result of prompt grading results.</td>
<td>a 2.5</td>
<td>8.3 41.7 41.7 8.3 0</td>
<td>b 1.8</td>
<td>30.8 61.5 7.7 0 0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38. Activities in report writing enhanced your competence in planning the sequence of operations.</td>
<td>a 2.9</td>
<td>8.3 25.0 41.7 16.7 8.3</td>
<td>b 2.0</td>
<td>23.1 69.2 0 0 7.7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SA = strongly agree  
A = agree  
UD = undecided  
D = disagree  
SD = strongly disagree

a = CC  
b = ACC
Appendix E7 Response distribution in student perceptions to comparative teacher roles and to equivalent programmed aids in the new training system.

<table>
<thead>
<tr>
<th>Comparative cases</th>
<th>Class</th>
<th>x</th>
<th>SA</th>
<th>A</th>
<th>UD</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. It was easier to understand through a lecture than through self-studying with a programmed text.</td>
<td>a</td>
<td>2.8</td>
<td>8.3</td>
<td>25.0</td>
<td>58.3</td>
<td>0</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>2.4</td>
<td>15.4</td>
<td>38.5</td>
<td>38.5</td>
<td>7.7</td>
<td>0</td>
</tr>
<tr>
<td>2. It was faster to study a programmed text yourself than to attend a lecture.</td>
<td>a</td>
<td>2.8</td>
<td>0</td>
<td>33.3</td>
<td>58.3</td>
<td>8.3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>2.7</td>
<td>15.4</td>
<td>30.8</td>
<td>30.8</td>
<td>15.4</td>
<td>7.7</td>
</tr>
<tr>
<td>3. It was more difficult to understand the teacher's demonstrations than to study a pictorial sequence of operations yourself.</td>
<td>a</td>
<td>2.4</td>
<td>25.0</td>
<td>33.3</td>
<td>25.0</td>
<td>8.3</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>4.0</td>
<td>7.7</td>
<td>0</td>
<td>15.4</td>
<td>38.5</td>
<td>38.5</td>
</tr>
<tr>
<td>4. It was more interesting to observe the teacher's demonstrations than to study programmed exercise leaflets yourself.</td>
<td>a</td>
<td>2.3</td>
<td>0</td>
<td>66.7</td>
<td>33.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>2.0</td>
<td>30.8</td>
<td>46.2</td>
<td>15.4</td>
<td>7.7</td>
<td>0</td>
</tr>
<tr>
<td>5. The teacher's emphasis during demonstrations was stronger than the emphasis given in programmed exercise leaflets.</td>
<td>a</td>
<td>2.0</td>
<td>16.7</td>
<td>66.7</td>
<td>16.7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>1.9</td>
<td>53.9</td>
<td>15.4</td>
<td>23.1</td>
<td>7.7</td>
<td>0</td>
</tr>
<tr>
<td>6. The teacher's demonstrations provided more confidence than self-studying on programmed exercise leaflets.</td>
<td>a</td>
<td>2.5</td>
<td>16.7</td>
<td>16.7</td>
<td>66.7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>2.0</td>
<td>30.8</td>
<td>53.9</td>
<td>0</td>
<td>15.4</td>
<td>0</td>
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<tr>
<td>7. Self-studying on a pictorial sequence of operations was easier to follow than the teacher's demonstrations.</td>
<td>a</td>
<td>2.9</td>
<td>0</td>
<td>16.7</td>
<td>75.0</td>
<td>8.3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>2.6</td>
<td>7.7</td>
<td>38.5</td>
<td>38.5</td>
<td>15.4</td>
<td>0</td>
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<tr>
<td>8. Less content was covered in the teacher's demonstrations than in programmed exercise leaflets.</td>
<td>a</td>
<td>2.3</td>
<td>8.3</td>
<td>50.0</td>
<td>25.0</td>
<td>8.3</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>3.1</td>
<td>7.7</td>
<td>7.7</td>
<td>69.2</td>
<td>7.7</td>
<td>7.7</td>
</tr>
<tr>
<td>9. The teacher's explanations of faults &amp; corrective measures were more understandable than the faulty/remedies guide.</td>
<td>a</td>
<td>2.6</td>
<td>8.3</td>
<td>50.0</td>
<td>25.0</td>
<td>8.3</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>2.4</td>
<td>15.4</td>
<td>46.2</td>
<td>23.1</td>
<td>15.4</td>
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</tbody>
</table>
Comparative cases

<table>
<thead>
<tr>
<th>Class</th>
<th>Student response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x</td>
</tr>
<tr>
<td>10. Referring to a faults/remedies guide was much faster than calling for teacher's help.</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>b</td>
</tr>
<tr>
<td>11. If you were having programmed exercise leaflets with you, you would be less likely to ask for teacher's help.</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>b</td>
</tr>
</tbody>
</table>

SA = strongly agree  
A = agree  
UD = undecided  
D = disagree  
SD = strongly disagree
Appendix E8: Response distribution of student preference in activities, events and conditions in the new and the traditional training systems.

<table>
<thead>
<tr>
<th>Traditional training system</th>
<th>Class Like</th>
<th>Neutral</th>
<th>Like</th>
<th>New training system</th>
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<tbody>
<tr>
<td></td>
<td>1 2 3 4 5</td>
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<tr>
<td>a = CC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b = ACC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Studying workshop theory in the class-room.
   a  6 0 35 18 41
   b  0 7 20 40 33

2. The sequence of topics given by the teacher.
   a 12 18 12 6 52
   b  0 27 7 20 46

3. The lesson given by the teacher.
   a 41 0 24 6 29
   b 13 13 40 7 27

4. Learning objectives not given.
   a 6 6 41 12 35
   b 0 7 20 33 40

5. Students must assemble prior to working in workshop.
   a 29 18 23 18 12
   b  7 20 20 20 33

6. Student attendance checked.
   a 12 29 18 18 23
   b 20 13 20 13 34

7. Working only in working hour.
   a 12 18 23 18 29
   b  0 0 20 0 80

8. Rest during working hours only with permission.
   a 0 6 41 24 29
   b 13 7 7 20 53

9. The sequence of workshop exercises given by the teacher.
   a 12 18 41 6 23
   b  0 13 20 40 27

10. Operations must follow given sequence.
    a 18 6 29 24 23
    b  7 7 6 40 40

11. Only descriptions given to the sequence of operation.
    a 0 6 53 18 23
    b  7 0 13 20 60

12. Solutions to faults must be asked for from teachers.
    a 12 0 23 24 41
    b  7 7 13 27 46

13. No pictorial illustrations of good and poor work given.
    a 6 12 41 23 18
    b  0 13 13 20 54

14. Quality of produced work measured from only the given drawing.
    a 17 0 65 12 6
    b  0 13 0 47 40

Quality of produced work measured from both the given drawings and grading sheet.

cont'd .......
### Traditional training system vs. New training system

<table>
<thead>
<tr>
<th>Traditional training system</th>
<th>New training system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Like</td>
<td>Like Neutral Like</td>
</tr>
<tr>
<td>a = CC</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>b = ACC</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Traditional</th>
<th>New training system</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. No review of workshop theory prior to actual production exercises</td>
<td>a 0 6 64 18 12</td>
<td>Review of workshop theory prior to actual production exercises</td>
</tr>
<tr>
<td></td>
<td>b 0 7 20 40 33</td>
<td></td>
</tr>
<tr>
<td>16. No review questions given to report assignments</td>
<td>a 0 6 35 24 35</td>
<td>Review questions given to report assignments</td>
</tr>
<tr>
<td></td>
<td>b 0 7 33 40 20</td>
<td></td>
</tr>
<tr>
<td>17. A report to be submitted every week</td>
<td>a 23 12 47 6 12</td>
<td>A report to be submitted after every exercise</td>
</tr>
<tr>
<td></td>
<td>b 13 20 26 20 20</td>
<td></td>
</tr>
<tr>
<td>18. Grades awarded only on certain exercises</td>
<td>a 12 12 47 17 12</td>
<td>Grades awarded to every exercise</td>
</tr>
<tr>
<td></td>
<td>b 7 7 7 46 33</td>
<td></td>
</tr>
<tr>
<td>19. Grades awarded by the teacher to finished work</td>
<td>a 18 29 29 6 18</td>
<td>Grades awarded by students to finished work</td>
</tr>
<tr>
<td></td>
<td>b 0 13 27 13 47</td>
<td></td>
</tr>
<tr>
<td>20. No workshop theory test</td>
<td>a 6 0 53 12 29</td>
<td>Workshop theory tested</td>
</tr>
<tr>
<td></td>
<td>b 0 7 27 20 46</td>
<td></td>
</tr>
<tr>
<td>21. No workshop practice test</td>
<td>a 12 6 41 12 29</td>
<td>Workshop practice tested</td>
</tr>
<tr>
<td></td>
<td>b 7 7 20 26 40</td>
<td></td>
</tr>
<tr>
<td>22. Teacher's demonstration of working techniques can be observed</td>
<td>a 35 0 53 6 6</td>
<td>Study working techniques only from programmed workshop exercise leaflets.</td>
</tr>
<tr>
<td></td>
<td>b 7 13 60 20 0</td>
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</tbody>
</table>

cont'd ......

**447**
### Actual conditions Class

<table>
<thead>
<tr>
<th>Actual conditions</th>
<th>Class</th>
<th>Like 1</th>
<th>Neutral 2</th>
<th>Like 3</th>
<th>Like 4</th>
<th>Like 5</th>
<th>Alternative conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>23. Work with simple examples prior</td>
<td>a</td>
<td>18</td>
<td>29</td>
<td>29</td>
<td>0</td>
<td>24</td>
<td>Work with actual production exercises right away.</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>40</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>24. A target time is given for each</td>
<td>a</td>
<td>18</td>
<td>29</td>
<td>18</td>
<td>6</td>
<td>29</td>
<td>No target time given.</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>27</td>
<td>20</td>
<td>40</td>
<td>13</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>25. A pre-test given in every lesson.</td>
<td>a</td>
<td>35</td>
<td>29</td>
<td>12</td>
<td>18</td>
<td>6</td>
<td>No pre-test given.</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>40</td>
<td>20</td>
<td>20</td>
<td>7</td>
<td>13</td>
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<tr>
<td>26. A post-test given in every lesson.</td>
<td>a</td>
<td>47</td>
<td>35</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>No post-test given.</td>
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<td>b</td>
<td>60</td>
<td>26</td>
<td>7</td>
<td>7</td>
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<tr>
<td>27. Exercises given in every lesson.</td>
<td>a</td>
<td>41</td>
<td>24</td>
<td>29</td>
<td>0</td>
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<td>No exercise given in any lesson.</td>
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<tr>
<td></td>
<td>b</td>
<td>60</td>
<td>20</td>
<td>13</td>
<td>7</td>
<td>0</td>
<td></td>
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<tr>
<td>28. Solutions to exercises given.</td>
<td>a</td>
<td>53</td>
<td>12</td>
<td>29</td>
<td>0</td>
<td>6</td>
<td>No solutions to exercises given in any lesson.</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>73</td>
<td>20</td>
<td>7</td>
<td>0</td>
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</table>

a = CC

b = ACC
involvement in student activities in the new training system.

<table>
<thead>
<tr>
<th>Student Activities</th>
<th>Degrees of teacher's involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class (1)</td>
</tr>
<tr>
<td>A. Study unit stage</td>
<td></td>
</tr>
<tr>
<td>1. Choosing topics in the study unit.</td>
<td>a 2.8</td>
</tr>
<tr>
<td></td>
<td>b 2.9</td>
</tr>
<tr>
<td>2. Studying topics in the study unit stage.</td>
<td>a 3.0</td>
</tr>
<tr>
<td></td>
<td>b 2.9</td>
</tr>
<tr>
<td>3. Completing exercises of topics in the study unit stage.</td>
<td>a 3.3</td>
</tr>
<tr>
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<td>b 2.9</td>
</tr>
<tr>
<td>4. Checking solutions to exercises of topics in the study unit stage.</td>
<td>a 3.3</td>
</tr>
<tr>
<td></td>
<td>b 3.0</td>
</tr>
<tr>
<td>5. Assessing achievement on the post-test of topics in the study unit stage.</td>
<td>a 3.3</td>
</tr>
<tr>
<td></td>
<td>b 3.1</td>
</tr>
<tr>
<td>6. Arranging timetable for studying topics in the study unit stage.</td>
<td>a 3.0</td>
</tr>
<tr>
<td></td>
<td>b 3.1</td>
</tr>
<tr>
<td>7. Allocating study place.</td>
<td>a 3.7</td>
</tr>
<tr>
<td></td>
<td>b 3.4</td>
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<tr>
<td>B. Practice unit stage (U-shaped work)</td>
<td></td>
</tr>
<tr>
<td>1. Choosing exercises of the practice unit stage.</td>
<td>a 2.4</td>
</tr>
<tr>
<td></td>
<td>b 2.4</td>
</tr>
<tr>
<td>2. Studying drawings and plans.</td>
<td>a 3.4</td>
</tr>
<tr>
<td></td>
<td>b 2.9</td>
</tr>
<tr>
<td>3. Producing workpieces.</td>
<td>a 2.4</td>
</tr>
<tr>
<td></td>
<td>b 2.2</td>
</tr>
<tr>
<td>4. Checking the sequence of operations.</td>
<td>a 1.9</td>
</tr>
<tr>
<td></td>
<td>b 2.3</td>
</tr>
<tr>
<td>5. Checking faults/errors on workpieces during operations.</td>
<td>a 2.3</td>
</tr>
<tr>
<td></td>
<td>b 2.1</td>
</tr>
<tr>
<td>6. Correcting faults/errors on the workpieces during operations.</td>
<td>a 2.3</td>
</tr>
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<td>b 2.2</td>
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<table>
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<tbody>
<tr>
<td></td>
<td>Class</td>
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<tr>
<td>5. Checking the plan of the sequence of operations.</td>
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</tr>
<tr>
<td></td>
<td>a</td>
</tr>
<tr>
<td>6. Producing workpieces.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a</td>
</tr>
<tr>
<td>7. Checking faults/erros on workpieces during the operations.</td>
<td></td>
</tr>
<tr>
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<td>b</td>
</tr>
<tr>
<td>8. Correcting faults/errors of the workpieces during operations.</td>
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<tr>
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<td>b</td>
</tr>
<tr>
<td>9. Checking/measuring the quality of the finished workpieces.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b</td>
</tr>
<tr>
<td>10. Grading the quality of the finished workpieces.</td>
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</tr>
<tr>
<td></td>
<td>a</td>
</tr>
<tr>
<td>11. Checking and approving the quality of the finished workpieces.</td>
<td></td>
</tr>
<tr>
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<td>b</td>
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\( a = CC \)

\( b = ACC \)
## Degrees of teacher's involvement

<table>
<thead>
<tr>
<th>Student Activities</th>
<th>Class</th>
<th>High (1)</th>
<th>Fair (2)</th>
<th>Low (3)</th>
<th>None (4)</th>
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</thead>
<tbody>
<tr>
<td>Checking/measuring the quality of the finished workpiece.</td>
<td>a 1.7</td>
<td>6</td>
<td>9</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>b 1.9</td>
<td>8</td>
<td>6</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Grading the quality of the finished workpieces.</td>
<td>a 1.7</td>
<td>6</td>
<td>9</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>b 2.3</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Checking and approving the quality of the finished workpieces.</td>
<td>a 1.8</td>
<td>5</td>
<td>10</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>b 2.0</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Arranging working timetables.</td>
<td>a 2.6</td>
<td>1</td>
<td>7</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>b 2.8</td>
<td>2</td>
<td>5</td>
<td>5</td>
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</table>

### C. Consolidating unit stage.

1. Choosing topics in the consolidating unit stage.      | a 2.7 | 1        | 3        | 12      | 0       |
|                                                        | b 3.1 | 1        | 3        | 8       | 6       |
2. Arranging timetable for studying.                     | a 3.1 | 0        | 2        | 11      | 3       |
|                                                        | b 3.3 | 1        | 3        | 3       | 11      |
3. Allocating study place.                               | a 3.6 | 0        | 2        | 2       | 11      |
|                                                        | b 3.5 | 0        | 3        | 3       | 12      |
4. Studying topics in the consolidating unit stage.      | a 3.4 | 1        | 2        | 3       | 10      |
|                                                        | b 3.2 | 1        | 4        | 4       | 9       |
5. Assessing the achievement on each consolidating unit topic. | a 2.9 | 1        | 2        | 11      | 2       |
|                                                        | b 2.6 | 2        | 6        | 7       | 3       |

### D. Exercise unit stage (A small vice)

1. Choosing production exercises of exercise unit stage.  | a 2.8 | 1        | 2        | 13      | 0       |
|                                                        | b 2.6 | 2        | 5        | 10      | 1       |
2. Arranging working timetable.                          | a 3.2 | 0        | 1        | 11      | 4       |
|                                                        | b 2.9 | 1        | 7        | 3       | 7       |
3. Studying the drawings and work.                       | a 3.1 | 1        | 3        | 6       | 7       |
|                                                        | b 3.0 | 1        | 6        | 3       | 8       |
4. Planning the sequence of operations.                   | a 3.1 | 1        | 3        | 6       | 6       |
|                                                        | b 2.5 | 4        | 5        | 5       | 4       |

cont'd .........
Involvement in student activities in the traditional training system.

<table>
<thead>
<tr>
<th>Degree of teacher's involvement</th>
<th>High</th>
<th>Fair</th>
<th>Low</th>
<th>None</th>
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</thead>
<tbody>
<tr>
<td>x</td>
<td>1.7</td>
<td>14</td>
<td>9</td>
<td>1</td>
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<tr>
<td>(51.9)</td>
<td>(33.3)</td>
<td>(3.7)</td>
<td>(11.1)</td>
<td></td>
</tr>
</tbody>
</table>

A. U-Shaped exercises

1. Choosing exercises.
   2. Studying the drawings.
   3. Selecting the sequence of operations.
   4. Producing workpieces.
   5. Checking faults/errors on workpieces.
   6. Correcting faults/errors on workpieces.
   7. Checking/measuring the quality of finished workpiece.
   8. Checking and approving the quality of finished workpieces.

B. The small vice

1. Choosing exercises of the small vice.
2. Studying the drawings.
3. Selecting sequence of operations.
4. Producing workpieces.
5. Checking faults/errors on workpieces during operations.
6. Correcting faults/errors on the workpieces during operations.
7. Checking/measuring the quality of finished workpieces.
8. Checking and approving the quality of finished workpieces.