

Scottish Certificate of Education

Standard Grade Arrangements in Technological Studies

At Foundation, General and Credit Levels in and after 1990

1988

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Introduction

The Arrangements for Technological Studies on the Standard Grade of the Scottish Certificate of Education are based on a Report of the Joint Working Party (JWP) of the Board and the Consultative Committee on the Curriculum which was issued to interested bodies in September 1987.

In finalising the Arrangements, the JWP has taken account of the submissions received from interested bodies. Where appropriate, aspects of the proposals contained in the Report have been clarified and modified in the light of these responses.

A Standard Grade examination in Technological Studies at Foundation, General and Credit Levels will be offered in and after 1990 on the basis of the arrangements detailed in this document.

The arrangements will permit centres to draw on the expertise of their staff, build on the interests of both staff and pupils and reflect local or national developments in technology. The arrangements are sufficiently flexible to allow the continuing evolution of pupil activities to reflect advances in technology.

1 Rationale

- 1 1** The growing impact of technology, particularly the "new" technologies arising from recent and current advances in microelectronics, on industry, commerce and the community in general has evoked varied responses in society. In some instances there has been an unquering acceptance of technological change, while in others there have been expressions of unease, indications of an inability to cope with change and, in some extreme cases, a total lack of acceptance of change. Consequently, it can be legitimately expected that schools should, through their curricula, ensure that young people are, as far as is possible, prepared to meet the challenges presented by these technological developments and to grasp the opportunities arising from them.
- 1 2** Many subjects within the school curriculum already deal with technology in one way or another. In each of their different ways Science, Modern Studies and technical education, for example, allow pupils to consider this topic from different standpoints. In addition, Action Plan modules on technology and initiatives such as the Technical and Vocational Education Initiative are also increasing the amount of technological coverage within the curriculum.
- 1 3** The inclusion of Technological Studies in the school curriculum should help to develop an understanding of technology as it is applied in industry and commerce. It should also help to develop an awareness of the applications of technology in the community, as well as a recognition of the responsibility to humanity and the environment that they impose. An appreciation of a need for flexibility by the individual with regard to work practices should also be achieved.
- 1 4** Technology as applied at present in industry and commerce has come some way from the time when most products were designed from first principles, built from discrete components, and understood by a small team of people. So advanced are the new technologies, so vast is the knowledge, that in many industries today products are designed and built on the basis of a series of inter-connecting components with the understanding of the construction team being limited to knowing the function of each part but rarely knowing how it carries out the task it does. Industry consequently sees a product as a "system" comprising a series of sub-systems with in each case only the input and output being of concern.
- 1 5** Technological Studies will require young people to derive practical solutions to problems through the application of a series of logical steps as in the systems approach (see Appendix I) and so begin to provide a framework for understanding. Emphasis will be on problem solving through the application of relevant knowledge, new knowledge being presented in the curriculum on a need-to-know basis. This will reflect in a miniature way the research and development work and manufacturing techniques of industry and through such awareness will develop the ability of young people to analyse the products of technological processes in terms of their functional requirements and marketability.
- 1 6** The problem-solving approach of the course demands that pupils are trained to approach tasks in a logical manner. The process-based course which follows will meet that requirement while still ensuring that the pupil's ability to innovate or demonstrate ingenuity is not stifled. It will also provide ample scope for pupils of differing abilities to achieve their individual potentials and to receive appropriate recognition.
- 1 7** The course deals with electronics, mechanisms, pneumatics, manufacturing, energy, structures and product analysis. Although listing these aspects of technology may make them appear discrete, in application, they are very often integrated. Real-life integration is emphasised throughout the course.

- 18** It was originally anticipated that biotechnology would also form part of the course. However, in attempting to draft a biotechnology unit for the course, it very soon became apparent that, if pupils were to be involved in the study of the industrial application of biological processes, the details of these processes would be inappropriate and the focus of attention would have instead to be the inputs and outputs and control of these processes. The control of these processes did not introduce any novel aspect to the course nor did the requisite hardware and software. Consequently, the topic has not been developed further than the justifiable inclusion of the required aspects of control in other parts of the course. Biotechnological problems can still be pursued under the headings listed in 1 7.
- 19** In an industrial society a healthy economy will depend upon the new technologies being adapted to useful purpose. This will require a constant inflow of engineers, technicians and technologists of varying levels of training and skills into the world of industry and commerce to maintain the rate of growth at an effective level. A course offered in secondary schools should not have as one of its purposes the production of trained or semi-trained technicians but should generate a level of interest high enough to influence pupils of either sex following it to consider job opportunities in industry and commerce. If Technological Studies can stimulate this interest it will have played a vital role in the future well-being of society. If in addition it allows those who do not intend to follow a career in technology to have an awareness of technology, it can ensure that technology is applied for the good for all.

2 Aims and Objectives of the Course

2.1 Aims

The Course in Technological Studies should fulfil the following aims.

- To encourage the acquisition of problem-solving skills

The technological process requires a variety of skills at different levels. Pupils should become aware of the different skills and should be encouraged to develop some of these through a range of activities including methodical design, assembly of systems, communication in technological situations and logical evaluation of solutions to practical problems of a technological nature. Pupils should be encouraged to apply initiative and creative thought along with knowledge gained within or outwith the course.

- To develop the pupils' ability to apply the systems approach to practical problem solving.

The course should provide the opportunity for pupils to apply the systems approach to the solution of technological problems. The emphasis should be on **what** a system does, i.e. the "black box" approach, rather than on **how** it does it.

- To allow pupils to comprehend the evolutionary nature of technology and to recognise the effect of technology on the quality of life and the environment.

While the structure of the course stresses the solution of technological problems, opportunity should be taken where appropriate to demonstrate the effects that the solution may have on the environment. Traditional technologies have changed the societies and environments in which people live and it is to be expected that the new technologies will have similar effects.

- To highlight the role of technology in manufacturing.

The course should develop an awareness of various manufacturing processes used in industry, the importance of their cost effectiveness, their effect on work practices, working environments and end products, and the increasing dependence on changing manufacturing methods for the economic well-being of industrial societies.

2.2 Course Objectives

Pupils having completed a course in Technological Studies should be able to:

solve, at an appropriate level, technological problems and evaluate solutions, carrying out calculations where necessary;

understand and apply the systems approach to the analysis of technological problems and to the synthesis of their solutions;

select and use resources as required;

understand and apply control techniques in the solution of technological problems;

evaluate the fitness for purpose of technological devices with particular emphasis on aspects of function and manufacture;

make measurements using appropriate units and standards of accuracy as required for particular technological purposes;

communicate technological information in verbal and graphical forms;

demonstrate knowledge and understanding of appropriate terminology, facts and concepts and of the function of technological devices, and apply that knowledge;

select, interpret and use technological information;

participate in the solving of technological problems on an individual or co-operative team basis;

demonstrate an awareness of the need to take account of energy changes.

3 Assessable elements of the Course

The assessable elements of the course, derived from the aims and objectives set out in Section 2, are as follows.

3 1 *Knowledge and Understanding*

The basic philosophy of the course is the seeking out of relevant knowledge and its application in practical problem-solving situations. Pupils will therefore require to understand fundamental concepts and principles which they will use in technological situations during the course.

3 2 *Technological Communication*

An essential aim of the course is to develop the ability of pupils to communicate in technological situations. Communication techniques should include a variety of verbal and graphical forms. Pupils should be able to interpret and present information in these forms. Amplification of the various techniques to be included is given in 5 2 2 and 8 9.

3 3 *Problem Solving*

The essence of this element is the practical application of a systems approach. This will require pupils to apply the logical sequences of the systems approach to solve practical problems. Such an approach does not preclude ingenuity and intuition.

The same techniques would also be applied to the analysis and appraisal of solutions to practical problems, whether they be the pupil's own or provided for product analysis.

Included in this element are the skills pupils should develop in assembling, testing and appraising solutions to practical problems. Manual dexterity will not be assessed.

For assessment purposes, Problem Solving has been divided into the following sub-elements:

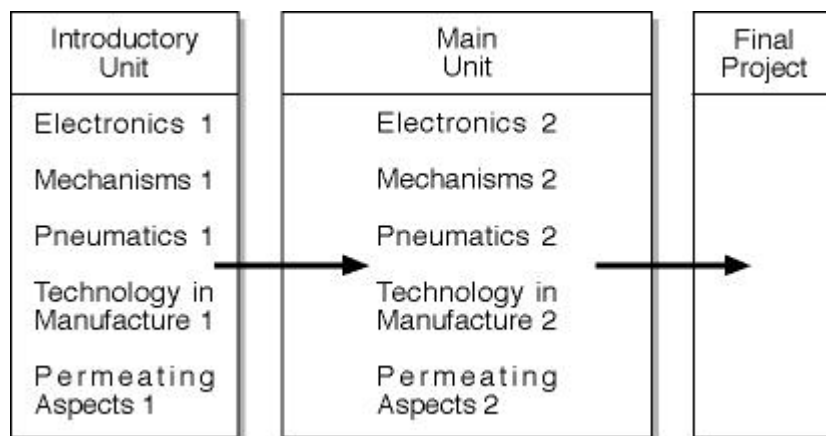
- Analysis of a Problem
- Performance Criteria
- Ideas for Solutions
- Building and Testing
- Evaluation

4 Course Structure

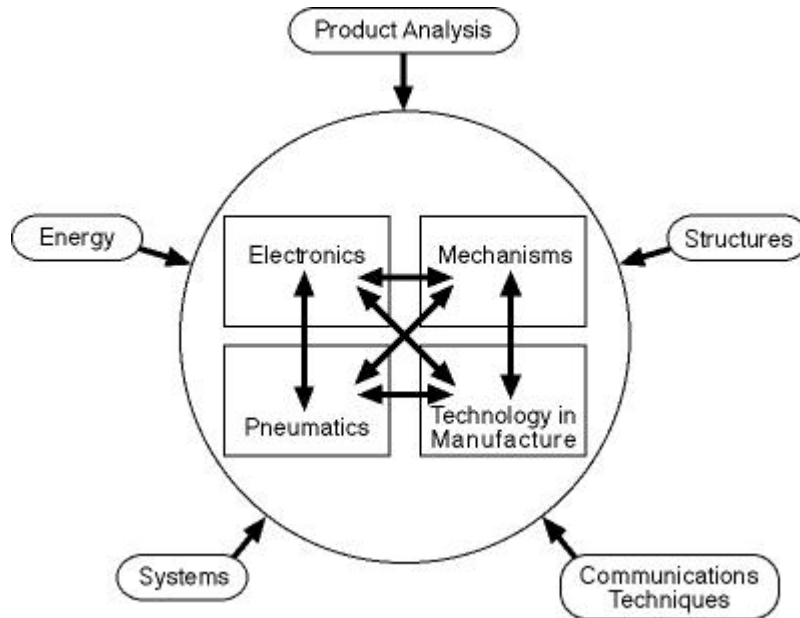
- 4.1** In order to simulate the integrated nature of real-life technological activity and to allow pupils to draw knowledge, understanding and experiences together in a meaningful way, the course is organised as follows.

Introductory Unit
Main Unit
Final Project

- 4.2** The Introductory Unit should have a duration of approximately 40 hours. This unit is designed as a "taster unit" which will, in addition to introducing pupils to the main areas of study, provide an introduction to the systems approach and problem solving. Initially, pupils should be introduced to problem solving in the discrete areas of study of Electronics, Mechanisms, Pneumatics and Technology in Manufacture, but as the course progresses, the realistic integration of these areas will become apparent. In addition, relevant aspects of Systems, Communication Techniques, Product Analysis, Energy and Structures should be introduced where appropriate. These are referred to below as permeating aspects.
- 4.3** The Main Unit continues the areas of study of the Introductory Unit with more extensive integration and to a greater depth and width. Approximately 90 hours should be devoted to this unit.
- 4.4** The Final Project will allow pupils to innovate on the basis of techniques and understanding gained in earlier work. In this component of the course the pupil will have full responsibility for the total technological process from its inception to realisation. The Final Project should receive an allocation of 15 to 30 hours and be carried out on an individual basis.
- 4.5** The structure of the course is summarised diagrammatically below.



- 46** The areas of study and the permeating aspects should interrelate throughout the course, as indicated diagrammatically below.



5 Areas of study and permeating aspects

5 1 Introduction

In considering the areas of study, their interrelationships should be borne in mind. To illustrate breadth and depth of treatment the permeating aspects and the areas of study are separated and described below. This should not be taken to have any implications for teaching approaches, for order of teaching or for relative importance.

In each part described below, the total content shown should be regarded as the maximum for the most able pupils. Pupils should be exposed to a range of activities, terminology and concepts which are progressively challenging and appropriate to their abilities.

While it is intended that knowledge will be acquired throughout the course, understanding should be gained through the application of that knowledge to the solution of problems. Some components and devices which could be used in appropriate pupil activities are indicated.

A computer, interfaced to a variety of output devices, may be used at various stages throughout the course. This would involve generating control commands using a selection of appropriate applications packages. The ability to write detailed computer programs is not precluded, but will not be assessed.

While commercial kits will play an important part in the course, undue reliance on such products should be avoided. Individual components, purchased or devised, will therefore be needed in order to provide a realistic range of problem-solving resources.

5 2 Permeating Aspects

5 2 1 Systems

The systems approach, as described in Appendix I, permeates the entire course and pupils should develop the ability to use this method and the appropriate terminology and diagrams.

5 2 2 Communication Techniques

This aspect is particularly significant in its contribution to the Technological Communication element of the course. Accordingly, the various techniques of communication should include: the written and spoken word, tabulated data, charts, graphs, flow diagrams, block diagrams, sketches, pictorial views, exploded diagrams, orthographic views, schematic diagrams, circuit diagrams, photographs and the use of computer peripherals. For graphical work the emphasis should be on interpretation rather than on the production of graphs and drawings.

Pupils should be involved in technical reporting (oral and written), should maintain a folio of course project work, and should use reference materials. Reference should be made to Appendix II for the recommended graphic symbols to be employed during the course and in examinations.

In addition, candidates should develop an appropriate technological vocabulary and be able to use it in the correct context.

5 2 3 Product Analysis

Analysing a product is a valuable way of reinforcing or introducing technological concepts. Priority of consideration should be given to the main functional requirement of the product, for example: structural strength, stability, production of heat, producing a turning effect, raising heavy objects, operating an alarm, magnifying or reducing physical quantities.

In addition, consideration should be given to the cost effectiveness of production methods, marketability of the product, energy transformations, materials utilised (simple qualitative treatment only) and operational safety where appropriate. It is anticipated that candidates will already be familiar with a variety of relevant technological facts covered in S1 and S2 such as the basic properties of materials.

5 2 4 Energy

In using the systems approach consideration should be given to energy transmission and transformation. Energy inputs, outputs and losses should be considered in energy audits for systems where appropriate. The more able pupils may be introduced to the concept of efficiency and to the measurement of energy and power.

5 2 5 Structures

The systems being studied should allow the investigation of physical configurations from a qualitative point of view; an analytical treatment of structures is not required. An appreciation of certain concepts will be necessary for pupils to be able to produce designs which are sufficiently strong and stable.

Concepts to be covered include: strength through shape, triangulation, redundancy, stability and centre of gravity, tension and compression, and beam cross-sections. The concepts of shear and torsion may be introduced to pupils judged capable of dealing with them.

5 3 ***Introductory Unit***

The Introductory Unit, for which approximately 40 hours should be allocated, lays the broad foundation for further, more detailed study and applications in the various fields of technology described in this section.

In this unit all of the problems posed should be capable of being solved using kits.

5 3 1 Electronics 1

In electronics the emphasis should be on the use of electronic "black boxes" (see Appendix I) to solve posed problems. Working models should be assembled using suitable construction kits incorporating electronic devices. A systems approach should be developed using various input units, process units and output units. Problems should be posed which involve:

input units such as sensors (e.g. light, temperature and moisture) and switches (e.g. push, toggle, reed);

output units such as buzzers, solenoids, motors, lamps;

process units such as transistors, invertors/NOT gates, logic gates AND and OR.

Problems should be structured to allow progression from the relatively simple, involving only input, process and output units to the more complex involving a variety of logic gates and other electronic devices. Although this part of the introductory unit is entitled "Electronics" this should not preclude the construction of working models incorporating a selection of other devices or components such as cams, gears and valves.

5 3 2 Mechanisms 1

In mechanisms, the emphasis should be on simple mechanical devices which singly, or in combination with electrical or pneumatic devices, will transmit and convert movement and force. A selection of simple motion-converting devices can be identified through observation of their function in existing industrial machines and systems. Problems should be posed which require the conversion of motion from linear to linear, rotational to rotational, and rotational to linear, through the use of simple levers and linkages, open and closed pulley systems, toothed belt or chain drives, simple gear trains and rotating cams with knife-edge followers.

These systems, singly or in permutation, should be incorporated into working models which could additionally involve solenoids and single-acting pneumatic cylinders. The need to investigate basic support techniques for pivoting levers and rotating shafts should arise naturally.

5 3 3 Pneumatics 1

The emphasis should be on the assembly and use of pneumatic systems to solve posed practical problems. Working models should be assembled incorporating single-acting and double-acting cylinders and 3-port valves. These devices could also be built into working models incorporating other areas of study.

Problems should be structured from the relatively simple, involving one single-acting cylinder, to the more complex, involving two or more cylinders interfaced with mechanical and/or electronic devices.

Industrial applications of pneumatics should be considered, and whenever possible observed, to link with the work covered in the classroom.

5 3 4 Technology in Manufacture 1

Technology in Manufacture should be introduced to pupils by involving them in solving problems which require the use of some form of robotic control and/or a simple automated handling system such as a form of conveyor belt. In addition, pupils should be introduced to computer control of rotating and oscillating mechanisms using an interface and appropriate software.

Technology in Manufacture may be illustrated through industrial visits, films or videos.

5 3 5 Permeating Aspects 1

For the purposes of the Introductory Unit the depth of treatment should be as follows:

- | | | |
|--------------------------|---|--|
| Systems | - | input, process, output, boundary, control, systems diagrams; |
| Communication Techniques | - | - production of simple block diagrams, flow diagrams, sketches and schematic diagrams; following structured design briefs; |
| Product analysis | - | examples such as torches and alarm systems; |
| Energy | - | simple electrical/mechanical transformations; |
| Structures | - | strength through shape, triangulation, stability. |

5 4 **Main Unit**

In this unit, for which approximately 90 hours should be allocated, the fundamentals established in the Introductory Unit should be further expanded and applied.

Since the essence of the course lies in its integrative nature, the Main unit should involve practical problem-solving activities using combinations of electrical, pneumatic and mechanical components and devices.

Where devices are listed, they should be considered as being representative of those currently available and illustrative of the range which might be used.

5 4 1 Electronics 2

Activities

These should involve the use of:

- | | | |
|--------------------|---|--|
| Input devices | - | change-over switches, sensors (e.g. smoke, sound proximity and infra-red), potentiometer. |
| Output devices | - | stepper motor, loudspeaker, electro-magnetic, signal emitter/transmitter. |
| Processing devices | - | NAND, NOR, EOR, comparator, non-inverting amplifier. |
| Other devices | - | counters, displays, memory, relay, latch, transistor switch, Schmitt trigger, pulse generator. |
| Instrumentation | - | digital multimeters, oscilloscopes, logic probes, computers, interfacers. |

Terminology

Pupils should develop a knowledge of, and be able to use in the correct contexts, the following terminology: monostable, bistable, binary, bits, word, buses, digital, analogue, integrated circuit (chip), printed circuit board, prototype board (bread-board), microprocessors and interface.

Concepts

Pupils should have a working knowledge of voltage, current, resistance and power, and of the quantitative relationships between them. Pupils should also have a working knowledge of polarity.

5 4 2 Mechanisms 2

Activities

These should involve the use of:

- | | | |
|-------------------------------------|---|--|
| Linear motion devices | - | compound linkages, coil springs. |
| Rotational motion devices | - | compound gear trains, bevel gears, worm and wheel, clutches, flange and universal couplings. |
| Linear to rotational motion devices | - | slider crank, rack and pinion. |
| Rotational to linear motion devices | - | cams, ratchet and pawl. |
| Other devices | - | support bearings. |

Terminology

Pupils should develop a knowledge of, and be able to use in the correct contexts, the following terminology: co-planar and non co-planar, fulcrum, tension and compression, transmission and conversion, potential and kinetic, multiplier, mesh and backlash, speed ratio, idler or intermediate gear, driver, driven, riser, follower, reciprocate.

Concepts

Pupils should have a working knowledge of: force, energy, power and efficiency and of the quantitative relationship between these. They should also have a working knowledge of friction and torque.

5 4 3 Pneumatics 2

Activities

These should involve the use of:

- | | | |
|-------------|---|---|
| Cylinders | - | single-acting and double-acting. |
| Valves | - | 3-port and 5-port valves, valve actuators (e.g. solenoid, lever, roller, button, pilot) flow restrictors, shuttle valves. |
| Other items | - | T-pieces, reservoirs, gauges, electrical interfaces, manifolds. |

Terminology

Pupils should be able to use the following terms correctly in context: force, energy, piping up, compressor, air line, outstroke, instroke, working pressure, main air, pilot air, exhaust, spring-return, one-way valve, state, port.

Concepts

Pupils should have an understanding of the quantitative relationship between force, area and pressure.

5 4 4 Technology in Manufacture 2

Activities

These should involve the use of:

- | | | |
|---|---|---|
| Computers in control | - | further applications of interfacing to robotic devices involving, for example, two or more motors and two or more axes of controlled movement; feedback. |
| | - | Computer Numerically Controlled (CNC) machines; use of applications packages. |
| | - | verification and execution, production of a machined article. |
| Computer Aided Design applications packages (CAD) | - | use of a CAD set-up, and "library" to produce displays and printouts of, for example, block diagrams, circuit diagrams, simple house plans, simple assembly drawings. |

Terminology

Pupils should be able to use the following terms correctly in context: hardware, software, line, program, port, absolute and incremental dimensioning, G Codes, joy stick, mouse, plotter, screen dump, edit.

Concepts

Pupils should have a working knowledge of: programmable robots, memory, computer control, interactive software.

5 4 5 Permeating Aspects 2

For the purposes of the Main Unit the depth of treatment should be as follows:

- | | | |
|--------------------------|---|--|
| Systems | - | open and closed loop, feedback, information. |
| Communication Techniques | - | circuit diagrams, technical drawings, pictorial views, use of conventions, maintenance of notebook and project record. |
| Product Analysis | - | examination of commercially available products which exemplify devices used in the activities of the areas of study. |
| Energy | - | energy transmission and conversions, losses, audit, efficiency. |

Structures - tension, compression, rigidity, balance, centre of gravity.

5.5 **Safety**

Throughout the course, safe working practices and recommended procedures must be observed. Pupils should be fully aware of the dangers of the various energy sources, machines, equipment and devices they use.

In particular, pupils should have a healthy respect for electricity and compressed air. They should be fully aware of the need for electrical insulation and of the design of safe pneumatic connectors.

It is recommended that wherever possible low voltage in preference to mains voltage supplies be used. However, it is essential that the inherent dangers even of low voltage supplies should be recognised.

6 **Project-based Activities**

6.1 **Course Work**

6.1.1 Course work should provide the opportunity for pupils to develop their skills, interests, and self confidence through practical and intellectual problem-solving activities. In particular it should develop a structured approach to problem solving, namely: analysis of the nature of the problem; establishing appropriate performance criteria for its solution; identification of alternative solutions; selection of a preferred solution in terms of available resources; realisation and testing of an optimum solution; appraisal in relation to the original problem, and identification of further applications.

6.1.2 In this course, project work is regarded as a learning situation which provides pupils with an enjoyable experience in the practice of inventive thought through applying knowledge, skills, and concepts to solving stimulating realistic practical problems, the degree of difficulty of the problems being appropriate to the pupils' ability. Problems set by the teacher should provide the opportunity for pupils to produce working models which replicate technological systems applicable to industrial techniques and processes. These problems should also allow pupils to interpret and present information in a variety of forms.

6.1.3 Activities should include both individual and group project work. It is essential that pupils be given opportunities to work in team situations which reflect the approach adopted by industry in problem-solving situations. Pupils will also have much to gain from the social interaction of group work.

6.2 **Final Project**

6.2.1 Each pupil will be required to undertake an individual Final Project. That Project will provide a basis for the assessment of the pupil's ability to analyse and solve practical problems and should where possible permit the integration of two or more of the areas of study of the course. In completing the Project, the pupil will have carried out practical investigations leading to the realisation and testing of a working model and to the production of a technological report. For the purposes of assessment of the Project, the emphasis will be placed on the **process** of problem solving rather than on the assembly of a product.

6.2.2 Selection of a suitable project topic is crucial and should be a matter for negotiation between the pupil and the teacher. Initially, careful consideration must be given to the pupil's interests and ability and to the availability of resources to ensure that the Project is

not so complex as to make it unachievable. The choice of Project for most pupils is likely to be teacher directed although some pupils may be able to suggest project topics. The prime objective should be to ensure that each pupil is allowed the opportunity to reach the highest level of Grade Related Criteria (see Section 8) attainable by the pupil. Projects which reflect the application of technology in industry and the home should help to motivate and sustain the interest of the pupil.

- 6 2 3 The time allocated to the Final Project should not exceed 30 hours, and should not be less than 15 hours. It is envisaged that the more able candidate might require the full allocation of time in order to meet the more demanding aspects of the Grade Related Criteria. The time allocated should include the time spent in research, experimentation, realisation of a working model, evaluation of the solution and compilation of a report. (See 6 2 4).

The teacher will have to adopt the roles of manager, facilitator, counsellor and prompter. Asking leading questions and prompting are to be encouraged if they will facilitate pupils' learning and development of problem-solving skills. Providing direct answers or help should however be used only as a last resort to enable pupils to move on to a later stage. Any significant assistance should be recorded for consideration at the final assessment stage. Pupils requiring assistance could be steered through a complex project if the Project is presented as a series of simple progressive stages.

Pupils should be well prepared and organised for the tasks ahead of them. They should be encouraged to:

- be aware of the criteria that they hope to meet;
- plan their own strategy;
- find and use appropriate resource-based learning materials;
- contribute to relevant discussion;
- use the teacher as a resource;
- make decisions and record progress in the report;
- be aware of deadlines for the assessment procedure;
- contribute to establishing an atmosphere conducive to safe, co-operative participation.

- 6 2 4 Each pupil should produce an individual Project report recording the work done. The report should indicate the strategy adopted and the practical activities undertaken, and should include photographic evidence of the final product together with an appraisal of the solution. Further photographs may be included to indicate significant stages in the development. Inclusion of suitable text, sketches, and diagrams should confirm the extent to which the pupil has succeeded in meeting the Grade Related Criteria. The emphasis throughout should be upon reporting on the stages of the problem-solving process.

The format of individual reports should be decided by the teacher and should take account of both the nature of the project and the pupil's ability to structure and describe the work. Teachers should include their own comments endorsing or qualifying the report prepared by the pupil. A form will be provided for this purpose.

The report should be presented on A4 paper (larger sheets should be folded to A4 size).

The Project will be internally assessed by the teacher and the report will subsequently provide the basis for external moderation.

7 Assessment for Certification

71 Certification

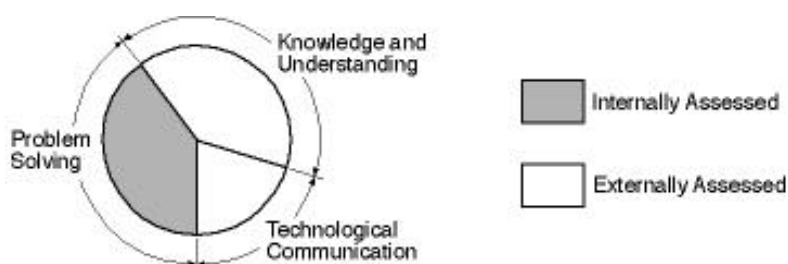
Certificates will record a profile of candidate attainment in the three assessable elements, Knowledge and Understanding, Technological Communication, and Problem Solving, each of which will be measured in relation to performance descriptions set out in the statements of Grade Related Criteria. In addition, the Certificate will record an overall award in the subject. The overall award will be the mean of the grades awarded in each of the elements, with Knowledge and Understanding, Technological Communication and Problem Solving being weighted 2:1:2 respectively.

72 System of Assessment

In Knowledge and Understanding and in Technological Communication, the final grade for candidates will be determined by external assessment only.

In Problem Solving, the final grade will be based on internal assessment. The internal assessment will be subject to external moderation.

The relative weightings of the three elements are illustrated in the diagram below.



73 External Assessment

An external question paper will be offered at each Level, Foundation, General and Credit, each paper covering Knowledge and Understanding, and Technological Communication. The grades assessed and time allocations will be as follows:

<i>Paper</i>	<i>Grades Assessed</i>	<i>Time Allocation</i>
Foundation	6, 5	1 hour
General	4, 3	1½ hours
Credit	2, 1	1½ hours

Marks will be allocated to each question and a total for each element obtained. The two grades associated with each level will be distinguished by setting two cut-off scores. The lower score will reflect a satisfactory overall standard of performance, the upper score a high overall standard of performance.

Examples of the types of questions to be used in the external examination papers are to be found in the specimen question papers issued with this document.

7 4 ***Presentations for External Papers***

At the time of presentation, centres will be required to indicate the Level(s) of the external papers which each candidate will attempt, as follows:

- Foundation Level only,
- or Foundation and General Levels only,
- or General and Credit Levels only.

Candidates presented at two Levels are not obliged to attempt both papers but are strongly advised to do so, since, other than as a result of an appeal, candidates can only be awarded one of the grades assessed by the paper(s) attempted, or grade 7.

The following table may be helpful as a guide to presentation.

<i>Expected External Grade</i>	<i>Presentation Level(s)</i>	<i>Grades Assessed</i>
7, 6	Foundation	6, 5
5, 4	Foundation and General	6, 5, 4, 3
3, 2, 1	General and Credit	4, 3, 2, 1

This arrangement allows in each case for a grade award higher or lower than expected (except at grades 1 and 7 respectively). A candidate expected to achieve grade 6 may choose to be presented for both the Foundation and the General papers; or a candidate expected to achieve grade 3 may choose to be presented for the Foundation and General combination of papers, thereby accepting that grade 2 or grade 1 will not be possible.

Candidates who attempt papers at two Levels will be given the better of the two grades achieved on these papers. Performance at one Level will **not** be taken into account in grading at the other Level.

7 5 ***Grade 7 and No Overall Award***

For any element, grade 7 will indicate that the candidate has, in the element concerned, completed the course but has now demonstrated achievement of any specified level of performance as defined by the Grade Related Criteria.

The Board will regard the submission of an estimate grade for an externally assessed element as evidence that the course has been completed in that element.

Candidates who have not complied with the assessment requirements in any element (e.g. due to unauthorised absence from the external examination or failure to submit a report) will be deemed not to have completed the course, in that element. Such candidates *will not receive a grade* for that element and hence *will not receive an overall award* for the subject. In such cases, however, if a grade is gained for any other element, that grade will be recorded on the Certificate.

7 6 *Internal Assessment*

For the Board's purposes, internal assessment must provide:

- an estimate of performance in each of Knowledge and Understanding, and Technological Communication;
- an assessment of performance in Problem Solving.

7 6 1 Estimates of Performance for Knowledge and Understanding, and Technological Communication

Presenting centres must submit to the Board, by 31 March of the year of the examination, estimate grades for each candidate for Knowledge and Understanding and for Technological Communication. The teacher should determine the estimate grades on the basis of each candidate's actual work. Estimates may be used by the Board for its internal procedures, including such cases as absence from external examinations, adverse circumstances and appeal. Evidence in support of these estimate grades should be retained by centres for submission to the Board if required.

Although assessment is likely to be carried out throughout the learning process, it is recommended that teachers assess the candidate's achievement at appropriate intervals and toward the end of the course. Each centre will decide which testing procedures will be used to provide the estimates for these elements.

Estimates should be based on overall performance in each of these elements

7 6 2 Internal Assessment of Problem Solving

Centres will be required to submit an internal assessment for Problem Solving for each candidate. This assessment should be derived from the candidate's performance in the Final Project and the evidence recorded in the candidate's Project Report. **It is recommended that Project Reports should not be more than 1500 words in length and should not require more than 12 sides of A4 paper.** (Larger sheets should be folded to A4 size for submission to the Board, if required.)

The grade awarded for this element should be arrived at by considering the **overall performance** of each candidate. While this will involve taking account of attainment in the five sub-elements, it is not necessary to record grades for each of these. It is recommended that progress in Problem Solving is monitored prior to allowing candidates to build or model their solutions.

The Extended GRC for Problem Solving and guidance on interpretation of these statements are given in paragraph 8 10.

For moderation purposes, a sample of candidates' Project Reports may require to be submitted to the Board by 31 March of the year in which the external examination is taken.

8 Grade Related Criteria

8.1 Definition

Grade Related Criteria (GRC) are positive descriptions of performance against which a candidate's achievement is measured. Direct comparisons are not made between the performance of one candidate and that of another.

8.2 Application of GRC

GRC are defined at three levels of performance: Foundation, General and Credit.

Awards will be reported on six grades, two grades being distinguished at each Level. The upper of the two grades at a given Level will be awarded to candidates who meet the stated criteria demonstrating a high standard of performance; the lower grade to those who demonstrate a lower, but still satisfactory, standard of performance.

There will be a seventh grade for candidates who complete the course but fail to meet the criteria for any Level.

8.3 Types of GRC

Summary GRC are broad descriptions of performance. They are published as an aid to the interpretation of the profile of attainment by candidates, parents, employers and other users of the Certificate.

Extended GRC are more detailed descriptions of performance. They are intended to assist teachers in making their assessments for each element, and to be used by examiners when conducting external assessment.

8.4 Knowledge and Understanding - Summary GRC

Foundation Level (grades 6, 5)

The candidate has demonstrated knowledge of simple technological facts, basic concepts and the functions of simple devices; and knowledge and understanding of technological terms and symbols relevant to these.

General Level (grades 4, 3)

The candidate has demonstrated knowledge of technological facts, complex concepts and the functions and applications of simple devices; and knowledge and understanding of relevant technological terms, symbols and basic concepts.

Credit Level (grades 2, 1)

The candidate has demonstrated knowledge of an extensive range of technological facts and the functions and applications of combinations of complex devices; and knowledge and understanding of relevant technological terms and complex concepts.

8 5 *Technological Communication - Summary GRC*

Foundation Level (grades 6, 5)

In a technological context, the candidate has demonstrated some ability to identify, extract and present single items of relevant simple information using given short texts which contain basic technological symbols, vocabulary, graphs, tabulated data, simple two-dimensional drawings and schematic diagrams.

General Level (grades 4, 3)

In a technological context, the candidate has demonstrated ability to identify, extract and present most of the relevant information in an ordered fashion using an appropriate communication medium.

Credit Level (grades 2, 1)

In a technological context, the candidate has demonstrated competence in identifying and extracting relevant information which is not immediately obvious, and is able to present unambiguously information which is accurate and concise, and structured in an appropriate format.

86 ***Problem Solving - Summary GRC***

Foundation Level (grades 6, 5)

The candidate has demonstrated ability to analyse a simple problem, to present and test a solution which meets a specified performance criterion, and to present a simple report on the success or otherwise of the solution.

General Level (grades 4, 3)

The candidate has demonstrated ability to analyse a problem, to establish a specification, to present and test a solution, and to offer suggestions for improvement in an evaluative report.

Credit Level (grades 2, 1)

The candidate has demonstrated ability to analyse a problem and to present a solution which meets an extensive specification established by the candidate. The candidate has chosen a solution after consideration of a variety of ideas, has subjected this solution to detailed testing, and has offered suggestions for further investigations and applications in a comprehensive evaluative report.

87 ***Descriptions of Grades***

These describe performance within Levels. They apply to each element.

Grade 6	The candidate has met the criteria for Foundation Level, demonstrating a satisfactory overall standard of performance.
Grade 5	The candidate has met the criteria for Foundation Level, demonstrating a high overall standard of performance.
Grade 4	The candidate has met the criteria for General Level, demonstrating a satisfactory overall standard of performance.
Grade 3	The candidate has met the criteria for General Level, demonstrating a high overall standard of performance.
Grade 2	The candidate has met the criteria for Credit Level, demonstrating a satisfactory overall standard of performance.
Grade 1	The candidate has met the criteria for Credit Level, demonstrating a high overall standard of performance.

88 Knowledge and Understanding - Extended GRC

Foundation Level (grades 6, 5)	General Level (grades 4, 3)	Credit Level (grades 2, 1)
The candidate has demonstrated:	In addition , the candidate has demonstrated:	In addition , the candidate has demonstrated:
knowledge of the functions of a range of simple devices* singly and in simple combination with other devices.	knowledge of the functions of a range of complex devices;** knowledge of the applications of the range of simple devices, used simply or in combination;	knowledge of the functions of combinations of complex devices; knowledge of the applications of combinations of complex devices;
knowledge and understanding of the technological terms and symbols used to describe simple devices and their functions;	knowledge and understanding of the technological terms and symbols used to describe the applications of simple devices and to describe complex devices and their functions;	knowledge and understanding of the technological terms and symbols used to describe the functions and applications of combinations of complex devices;
knowledge of some simple technological facts and basic concepts, such as the systems approach, energy conversion, control, stability and the triangulation of frames.	knowledge of some technological facts and complex concepts, such as voltage, interfacing; understanding of basic concepts such as the systems approach, energy conversion, control, and the triangulation of frames.	knowledge of an extensive range of technological facts; understanding of complex concepts, such as power, interfacing, torsion and shear

Descriptions of grades are given in 8 7.

* "Simple" electronic devices (with the exception of AND and OR gates) would have a single output and a digital signal, such as light sensor, buzzer, inverter (NOT gate).

"Simple" mechanical devices would be those which convert linear motion to linear motion, or rotational motion to rotational motion, at a single stage, such as simple lever, simple gear train, coil spring.

"Simple" pneumatic devices would be those with a single input and a single output in any one state, such as single-acting cylinder, 3-port valve, non-return valve.

** "Complex devices" would be devices, such as stepper motor, other logic gates, compound gear train, slider crank, double-acting cylinder, 5-port valve.

89 Technological Communication - Extended GRC

Foundation Level
(grades 6, 5)

General Level
(grades 4, 3)

Credit Level
(grades 2, 1)

Interpretation

The candidate has demonstrated ability to identify and extract a single item of relevant information from:

In addition, the candidate has demonstrated ability to identify and extract related items of relevant information from:

In addition, the candidate has demonstrated ability to identify and extract related items of essential relevant information, which are not immediately obvious, from:

short lists or simple sentences containing basic technological vocabulary within a short text;

sentences containing basic technological vocabulary within a text;

sentences containing comprehensive technological vocabulary;

photographs or technical illustrations of 3-dimensional objects;

3-dimensional line drawings;

symbols, 2-dimensional drawings and schematic diagrams of simple circuits and assemblies;

orthographic views of simple assemblies;

orthographic views of assemblies, 3-dimensional drawings and schematic diagrams of more complex systems;

graphs and tabulated data;

block diagrams representing several sub-systems in series with several inputs and outputs.

block diagrams representing sub-systems in parallel and including a feedback loop.

block diagrams representing simple sub-systems in series.

Presentation

The candidate has demonstrated ability to convey a single item of relevant information in skeletal form, using the following media as appropriate:

In addition, the candidate has demonstrated ability to convey related items of relevant information in an ordered format, using the following media as appropriate:

In addition, the candidate has demonstrated ability to convey related items of essential relevant information which are concise, accurate and logical, using the following media as appropriate:

list or simple sentences containing some basic technological vocabulary;

sentences containing adequate technological vocabulary;

sentences containing a comprehensive technological vocabulary;

simple, straight-line, 3-dimensional pictorial views;

straight-line, 3-dimensional pictorial views;

detailed, 3-dimensional pictorial views including curved surfaces;

simple orthographic views of a simple device or assembly;

two detailed orthographic views of a complex device or assembly;

complex circuit and schematic diagrams and appropriate symbols;

simple circuit and schematic diagrams and appropriate symbols;

tabulated data;

graphs;

block diagrams representing simple sub-systems in series.

block diagrams representing several sub-systems in series with several inputs and outputs.

block diagrams representing sub-systems in parallel and including a feedback loop.

Descriptions of grades are given in 8 7.

8 10 Problem Solving - Extended GRC

Foundation Level
(grades 6, 5)

The candidate has demonstrated ability:

Performance Criteria

to recognise a major performance criterion for a system or simple sub-system;

Ideas for Solutions

to offer an idea to meet a given performance criterion;

Building and Testing

to build a solution and test it against a given performance criterion;

Evaluation

to report in simple terms on the success or failure of the solution in meeting the given performance criterion.

General Level
(grades 4, 3)

In addition, the candidate has demonstrated ability:

to establish a specification for a system;

to offer alternative ideas to meet given or identified performance criteria;

to build a solution and test it against given or identified performance criteria;

to provide a report which considers some alternative solutions, describes performance of the developed solution in meeting the given or identified criteria and includes suggestions for further improvement.

Credit Level
(grades 2, 1)

In addition, the candidate has demonstrated ability:

to establish an extensive specification for a system;

to offer alternative ideas to meet the established specification;

to build a solution and test it against a variety of performance criteria;

to provide a detailed report which justifies the choice of the developed solution in meeting the identified criteria, and includes, for example, relevant results, suggestions for further investigations and other applications.

Descriptions of grades are given in

The Systems Approach

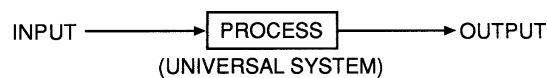
The systems approach is sometimes called a "top-down" approach, it focuses on the functional requirements of the total system and the relationships of component parts. Although technological applications are becoming increasingly more complex, they can be more readily understood by identifying systems and sub-systems. This approach encourages analysis to a level of detail appropriate to the learning need or problem to be solved.

A system may be defined as anything which performs a function and provides a response. In Technological Studies a system may be considered as an assembly or combination of components or devices which together perform a function.

A system can therefore be defined as:

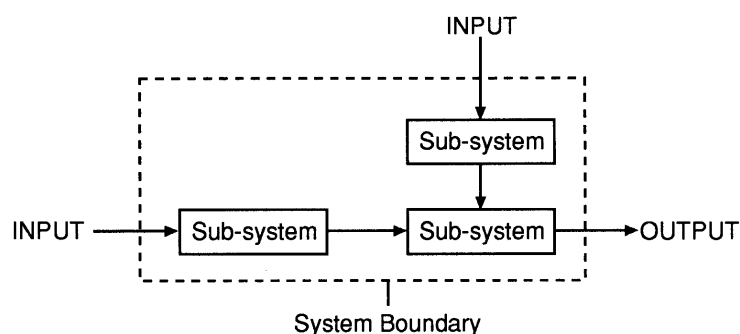
- an entity which consists of interdependent devices or components;
- an assembly of devices or components connected together in an organised way;
- an assembly of devices which can provide a response.

Any system which can be defined in terms of "input - process - output" is known as the "universal system", as shown in the diagram.

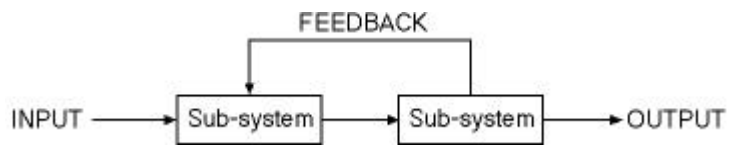


A system may be broken down into a collection of sub-systems within a boundary. Depending on the complexity of the system, the level of analysis and the inter-relationships of the sub-systems, these sub-systems can be represented in a variety of forms, such as the following.

Example A



Example B



A crucial aspect of the systems approach is that it is possible to stop at any level of analysis and represent a sub-system as a "black box", i.e. a system with inputs and outputs. The essence of the systems approach is that the details of the internal operations of black boxes can be ignored and that only the input and outputs need be considered.

Further exposition of the systems approach and associated terminology will be provided in due course.

Appendix II








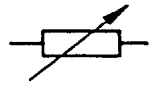


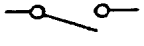

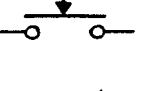

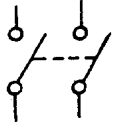




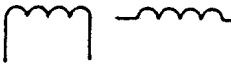
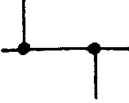



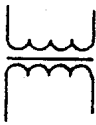
Graphic Symbols

The purpose of this appendix is to present the symbols considered to be most appropriate for the teaching of Technological Studies in secondary schools.

The list is not intended to be definitive and pupils should be encouraged to research appropriate symbols which have been omitted, as the need arises.

ELECTRONICS

Recommended B.S. - PP7303:1986, PP7307:1986

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
Alternating Current		Fuse	
Variability		Fixed Resistor	
Primary or Secondary Cell (long line is positive)		Resistor (with moving contact)	
Battery of Primary or Secondary Cells		Variable Resistor	
Earth		Resistor (fixed tapping)	
Switch (single pole, single throw)		Voltage Divider (with moving contact)	
Switch (single pole, double throw)		Light dependent resistor	
Switch (double pole, single throw)		Thermistor	
Conductors Crossing (No connection)		Capacitor (general)	
Junction of Conductors		Winding (general)	
Double Junction of Conductors		Winding (with core)	
Filament Lamp		Transformer (general)	
		Transformer (with core)	

ELECTRONICS (continued)

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
Microphone		LOGIC GATES NOT (-) e.g. \bar{A} AND (.) e.g. $A.B$ OR (+) e.g. $A+B$ NAND e.g. $\overline{A.B}$ NOR e.g. $\overline{A+B}$ EOR (Exclusive OR) 	
Earphone			
Loudspeaker			
Ammeter			
Voltmeter			
Amplifier (general)			
Motor			
Generator			
Relay			
Buzzer			


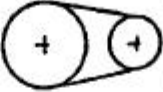


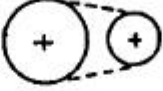


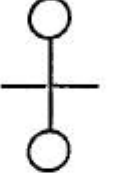
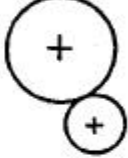

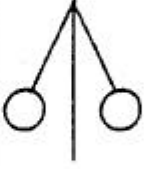
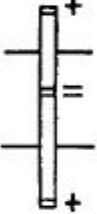

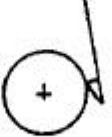
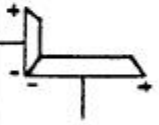
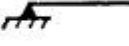
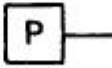
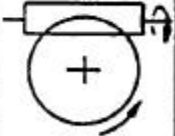



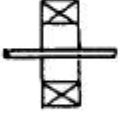

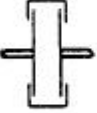
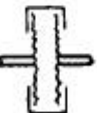

PNEUMATICS

CYLINDERS					
Single-acting		Single-acting (spring return)		Double-acting	

PNEUMATICS (continued)

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
DIRECTIONAL CONTROL VALVES		VALVES - FLOW CONTROL	
Unit for Controlling Flow or Pressure		NON RETURN	
One Flow Path		Free N.R. Valve	
Two Closed Ports		Spring Loaded N.R. Valve	
Two Flow Paths		Shuttle Valve	
Two Flow Paths and One Closed Port		Throttle Valve (simplified)	
Control Valve 2/2		With Fixed Output	
Three Port Valve		Variable Output	
Five Port Valve		Shut off Valve	
Exhaust Port		FLOW LINES AND CONNECTIONS	
CONTROL METHODS		Working Line (flow and return)	
Push Button		Pilot Control Line	
Spring		Flexible Pipe	
Roller or Plunger		Pipeline Junction	
Solenoid		Crossed Pipelines (not connected)	
Plunger		Pressurised Reservoir	
Lever		Air Pressure Source	
Air		Air flow	

MECHANISMS

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
MOVEMENT					
Linear		Belt Drive		Torsion Spring	
Rotational		Chain Drive		Torsion Spring	
Linear (reciprocating)		Flywheel		Spur Gears	
Rotational (reciprocating)		Governor		Spur Gears (+ Movement towards observer)	
Fulcrum		Ratchet		Bevel Gears	
Lever and Fulcrum		Pump		Worm and Wheel	
Shaft		Compression Spring		Rack and Pinion	
Ball or Roller Bearing		Tension Spring			
Coupling					
Flexible Coupling					
Cam					

Methodology

- 1 The course in Technological Studies should be activity-based. It should be stimulating, exciting and relevant, taking account of the applications of technology to be found in the home, work place, community and leisure situations, and should allow all pupils to gain a sense of achievement which accords with their ability.
- 2 Since the emphasis of the course is on the application of the systems approach to practical problem-solving, a variety of teaching and learning approaches will require to be used to develop the pupils' problem-solving skills in a technological context. These may include, for example, short teaching inputs, group sessions, resource-based learning and units for individual study. Some practical work may be undertaken by pupils on an individual basis. Nevertheless, while it is not possible to replicate authentically the common practice in industry of establishing "Project Teams" to solve particular problems, opportunities should be provided to allow pupils to work in groups, co-operating in joint ventures.
- 3 The use of project briefs for practical activities is recommended. This will allow the development of a carefully structured programme, which will lead pupils through the course with progressive challenges according to ability.

In the early stages of the course the project briefs should contain problems of a closed nature - a number of short, specific problems to be tackled using given resources to achieve predicted outcomes. These tasks should be set in order to:

familiarise pupils with a method of recording the development of a solution to a problem;

introduce the logical steps of the systems approach to problem solving;

begin to develop pupils' understanding of fundamental concepts across the fields of technological studies;

provide a means of formative assessment as well as of diagnostic assessment.

As the course progresses and as pupils' abilities develop, the project briefs should gradually become more open and more demanding. It should be recognised that for the least able, project briefs containing given specified problems may be required for the duration of the course.

- 4 Skill in processing information is an essential aspect of technological capability. Accordingly, at appropriate stages of the course, pupils should be encouraged to carry out independent research using resources within and outwith the school and to extract and convey information using a wide variety of media.
- 5 Coping with a wide ability range in one class, as will be the case in many schools, requires careful attention to be given to differentiation. It would be unrealistic, for example, to expect a particular project brief to be appropriate for all pupils. Formation of groups according to ability would be reasonable. While there will be occasions when whole-class activities are desirable and necessary, practical problem-solving tasks will require to be set for groups.

The Extended Grade Related Criteria show the expectations of achievement for the award at the various Levels in each of the three elements.

The wording used in setting the "problem" in project briefs is particularly important. In the early stages of the course the differences may be minimal but as the course progresses and pupils build on the range of experiences offered them, the differences in demands will become quite marked.

To help pupils to record the various stages in the problem-solving process it may be useful if in the early stages of the course they use prepared forms ranging from structured "one word" completion type to blank sheets with only headings indicated.

- 6 Although, in the early stages of the course, the areas of study may appear to be discrete, such artificial boundaries rarely exist in real life. Accordingly, the interrelationships of the areas of study should be reflected in the pupil activities (see Section 4 6).
- 7 Throughout the course pupils should use a variety of sets of components and devices to produce working solutions to technological problems. It is highly desirable that all these sets are mutually compatible, to allow pupils to assemble working models without the frustration of improvising the inter-connections or the need for craft skills beyond their level of competence.
- 8 Given the variety of teaching and learning approaches to be employed, such as individual and group activities, the use of work stations, demonstrations and guided discovery, didactic teaching and discussions, and the use of visual aids, videos and films, and out-of-school visits, the teacher must be prepared to operate in team situations and as organiser, consultant, assessor and resource manager. Appropriate technician support would however be desirable.

Interpretation of Extended GRC for Problem Solving

Pupils should be encouraged to tackle projects which **integrate** two or more of the main areas of study.

In the following guidance, for each sub-element, a breakdown of **typical minimum performance** at each of grades 1 to 6 is provided. **In carrying out assessments, teachers should not be restricted to these descriptions** as, due to the wide range of suitable projects, there will be other performances which merit equivalent grades. For example, where the EGRC for *Analysis of a Problem* state "feedback loops" at Credit Level it is possible to award a grade 1 or 2 for an equivalent performance which does not utilise a feedback loop but shows understanding of the links connecting various sub-systems of the project involved.

Analysis of a Problem

In analysing a problem, the candidate should identify the essential features of the system, most likely in the form of a block diagram. These features will include the inputs to and outputs from the system or sub-systems and the relationship between them.

Differentiation between grades is based on the degree of analysis in systems terms (see Appendix I).

One typical performance at each grade could be: the candidate draws

- 6 one systems diagram, with prompting;
- 5 one systems diagram;
- 4 two sub-systems diagrams;
- 3 two sub-systems diagrams and states valid information on the relationship between sub-systems;
- 2 sub-systems diagrams which show clearly appropriate linkages between sub-systems;
- 1 sufficient sub-systems diagrams to describe fully the analysis of the problem.

Performance Criteria

Performance Criteria (PC) range from a simple statement of what the system must do, to a complete specification which includes factors such as the working environment, safety, cost and appearance. Differentiation is based on the extent and appropriateness of the specification which is **identified by the candidate** prior to building the project.

One typical performance at each grade could be: the candidate

- 6 recognises one PC drawn from the problem statement;
- 5 identifies one PC;
- 4 identifies two PC;
- 3 identifies two PC and gives a short specification;
- 2 identifies several PC and gives extensive specification;
- 1 identifies almost a full specification.

Ideas for Solutions

The candidate should consider a variety of ideas by drawing on previous course content, personal experience and observation. The phrase "alternative ideas" should for example be interpreted as follows - alternative means of producing rotary motion could be gears, belt-drive, variable speed electric motor, pneumatic motor, etc. It should be noted that while **integration is desirable** at grades 3, 2, and 1 there may be projects of equivalent difficulty which, although not of an integrative nature, are still worthy of such grades.

One typical performance at each grade could be: the candidate offers

- 6 one idea for a solution, likely aimed at one PC;
- 5 one practicable idea for one PC;
- 4 two ideas aimed at one PC;
- 3 two ideas aimed at one PC in an integrated project;
- 2 comparison of alternative ideas for at least two PC;
- 1 comparison of alternative ideas and justification of selected solution.

Building and Testing

The level of manual dexterity displayed is not to be assessed. However, where the candidate concentrates on building to the exclusion of testing, it may be possible to justify grade 5 or even grade 4 in view of the extent of the building and modifications actually carried out.

One typical performance at each grade could be: the candidate

- 6 produces a model;
- 5 tests a working model against one PC;
- 4 tests a model against two PC;
- 3 tests an integrated model against two PC;
- 2 tests an integrated model against three PC;
- 1 shows evidence of carrying out logical and appropriate tests.

Evaluation

Evidence should be sought of the candidate having examined the performance of the developed solution, in terms of the function/suitability of selected devices and how well each performance criterion has been met.

One typical performance at each grade could be: the candidate

- 6 states that the solution did/did not work;
- 5 states that the solution met one PC;
- 4 evaluates the solution against two PC;
- 3 evaluates the solution against two PC and suggests further improvements/modifications;
- 2 gives detailed comment, drawing meaningful conclusions;
- 1 gives detailed comment, drawing conclusions and suggesting further work.

