TEACHER NOTES

ABOUT TEP

The Technology Enhancement Programme, funded by the Gatsby Charitable Foundation and managed by the Gatsby Technical Education Project, has the broad aim of enhancing and enriching technology education throughout the UK. It has a particular interest in supporting designing and making in a rapidly changing modern world and strongly believes in the principle of "learning through doing".

TEP is a rapidly growing organisation that offers:

- *expert subject advice through its central team of advisers,*
- *INSET and a national Summer School,*
- *regular updates on developments in technology education,*
- *rapid access to a wide range of unique physical, printed and multimedia resources.*

ABOUT TEP PUBLICATIONS

All TEP publications are photocopiable and do not prescribe what should be taught or how it should be taught. TEP has absolute confidence in the professional judgement of teachers to selectively copy or edit the material as they believe appropriate.

This book contains six project outlines or narratives which follow a similar structure:

- Overall subject context
- Design brief
- Specification
- Design constraints
- Guide to design and manufacturing
- Evaluation

These project elements are in the hands of the teacher who might, for example, want to set a very specific context, an alternative design brief, or limit (or widen) the resources available.

The *bookmarks* in the right hand margin are placed there for teachers. They highlight the structure of each project, provide a commentary where appropriate, give references to Study Files - and flag up maths and science opportunities. The bookmarks can easily be taken out when the material is photocopied.

ABOUT MANUFACTURING

In *Manufacturing* each of the 6 projects has been carefully considered in terms of technical support for pupils. It is anticipated that some use will be made of pre-formed components - e.g. motor mounts - to avoid presenting pupils with too many manufacturing tasks, or tasks which are too difficult.

The projects can be presented as tightly structured tasks (e.g. "focused task", "minor project"), or as *support* for a more open-ended activity ("capability task", "major project" etc.) Each task anticipates the specific problems pupils are likely to encounter in designing and making mechanical systems and provides a "menu" of technical options. These have been carefully thought out so that they are within the range both of pupils' capability and the physical resources that might be offered. All the tasks have been trialled, and success in making *something* work is virtually guaranteed. Ultimately, it is up to pupils to consider the "menu" elements and combine (and add to) them through intelligent decision making.

Each project is presented as a structured design and make task designed to occupy a nominal 5-10 hours of curriculum time. Each project provides basic information, calls for some investigation but also demands that pupils make some fundamental design decisions.

Project 1. The "universal press tool" is a very simple (and inexpensive) concept and was designed to enable pupils to produce precisely formed metal components that can be consumed in prototype work. Pressure can be applied either using a fly press or a larger bench vice. It will accommodate tinplate as well as aluminium but the former presents a more dangerous edge when cut. It is clearly desirable to cut metal using a guillotine and for thin gauge aluminium, a PCB guillotine (as illustrated) is ideal.

Project 2. The wire mould is very easily fabricated, but any strip "wire" cut using a guillotine needs straightening first by pulling - e.g., through a wad of cloth or paper. It is advisable to insist that pupils draw the intended wire profile on graph paper. This enables them to calculate the length of wire needed - and it also leads to the possibility of estimating volume of plastic required.

Under no circumstances should pupils be allowed to spray wire and/or mould case with release agent ! One initial light coating of the mould is sufficient for up to 50 mouldings.

Hot melt glue guns must only be used under strict supervision and with all normal safety precautions taken. On many models it is necessary to hold the protruding gluestick at the rear of the gun and push it down as well as operating the trigger to ensure the glue fills the mould. When a small spot of glue appears at the indicator hole, this signals that the mould is full. Further pressure simply pushes the wire outwards in the mould.

After the glue gun has been on for up to 10 minutes, it is advisable to switch off. This prevents heat conducting along the gluestick which then appears in a fused condition at the wrong end of the gun when pressure is applied!

If a laminated mould is made, the sprue entry hole should be as large in diameter as possible (e.g., 5mm) and as short as possible. Although this means there will be a larger sprue mark when the sprue is cut off, it does make it possible to fill the mould more easily. It should never be necessary to heat or vent the mould to facilitate filling.

Project 3. Manufacture of the pen involves quite straightforward measuring and turning. The turning can be done on a lathe of "conventional" size or by using a miniature model makers' equivalent. For measuring, digital read-out callipers, although still quite expensive, have come down in price and are quite robust. They are very easy measuring instruments for pupils to use in precise work.

Project 3 refers to a study file on electroplating. The electroplating bath can be made up using chemicals readily available in most school laboratories or alternatively a kit can be obtained (see Component Suppliers).

Project 4 examines the technique of vacuum forming in the context of creating an accurate clock. The context (introduction) emphasises the remarkable level of accuracy of a cheap quartz movement that pupils probably take for granted. Given the standard of accuracy, the clock might be used for accurate timing of telephone calls, process timing, event timing etc. Maths and science extensions to this project might include a consideration of atmospheric loading on the mould during vacuum forming.

Project 5. Re-inventing the paperclip appears to be a very simple challenge but offers a fascinating variety of design and manufacturing challenges. It is easy to produce a result of some kind, but quite difficult to produce a repeatable output of useable products. However, the basic requirement - wire - is inexpensive and can become the focus of a practical homework exercise. Many fundamental concepts of metallurgy can also be taught in relation to handling and manipulating wire - e.g. strain hardening, fatigue, elastic/plastic behaviour etc.

The problem of creating a number of identical parts is also a good introduction to the design of production tooling; again, many fundamental principles can be taught effectively around this relatively simple production task. The interchangeable pin method of tooling provides a very simple "bottom line" solution, but also provides a starting point for more advanced solutions to the problem.

Project 6. It has long been the belief of TEP that sheet metal - e.g. pre-anodised or polymer pre-coated - can and should be used for precision making through fabrication. This project invites students to go one step further and design and make *generic* component parts with the potential for assembly into models etc. Given three basic items of equipment - a guillotine, punch tool and folding unit - the component parts for a variety of prototyping and construction systems can be manufacturing in quantity and at low cost.

The resulting product might be envisaged for use by younger children (BUT NOTE THE SAFETY IMPLICATIONS FOR USING SMALL PARTS) or for use by peers - or even professional model makers. It is possible to produce interesting and attractive kit parts whose potential for modelling work can be proven simply by making up into a variety of configurations or working models. This project is also an object lesson in introducing the principle of interchangeable parts and the problems of manufacturing components to suitable tolerances.

TEP CRITERIA

Investigate

1. The properties of a (selected) range of materials.

2. The limitations of the brief in terms of performance of the product related to:

   • client requirement,
   • issues of safety, reliability etc.

Construct/make the product

1. Produce a design specification, reflecting the necessary limitations of the design brief.

2. Generate a range of design proposals, reflecting the design specification.

3. Use modelling/prototyping techniques (visual and/or product) to explore, modify and confirm design proposals.

4. Based upon the chosen design, generate a production specification to include:

   - working drawings to BS 308,
   - a phased time plan, outlining the main stages of manufacture,
   - identification of appropriate tools (hand and machine) and equipment,
   - identification and selection of appropriate materials.

5. Manufacture the product, to the specified level of quality and within the identified time scale.

Test/evaluate the product

1. Apply quality checks to the product during manufacture for:

   - dimensional accuracy,
   - production within specified tolerance range,
   - production of appropriate degrees and types of surface finish.

Apply the making process to a manufacturing engineering context

1. Analyse the changed requirements when scaling up the manufacture of the product.

2. Devise a production schedule for the manufacture of the product identifying and sequencing key operations.

COMPONENTS SUPPLIERS

EMA

EMA Ltd.,
58-60, The Centre,
FELTHAM,
Middlesex,
TW13 4BH
Tel. 081-890 5270

Butyrate tubing, pen components etc.
“Universal press tool”, handpunch, plastic bearings etc.

Mould case, glue gun, glue sticks

(Nb. this firm currently offers starter kits for the manufacturing units)

Teaching Resources

Teaching Resources
Technology Education Centre,
Middlesex University,
Trent Park,
Bramley Road,
London,
N14 4YZ
Tel. 0181-447 0342

"Universal press tool", handpunch, plastic bearings, electroplating kit, pre-coloured metal, mould case, glue gun, glue sticks, etc.