CAD/CAM IT!

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The development of suitable design and make assignments which encompass computing applications for design and technology project work in secondary schools is fraught with problems. Although the amount of suitable hardware and software available has increased greatly in recent years, design and technology departments can usually only afford to buy a small number of machines at any one time; these tend to be spread around the different workbases.

Schools often have an information technology facility, which is usually a room full of computers with a range of generalist software available. This type of facility is generally in great demand and has to be booked in advance. Unless the school has had a large capitation allocation or grant, design and technology departments tend to buy a machine for each workbase every few years. Due to the very nature of technological development these machines have very little in common with one another, often requiring different software and a whole new learning curve. They are often computer numerically controlled (CNC) machine tools, such as lathes and milling machines which, after initial staff enthusiasm, are found gathering dust in the corner of a storeroom, only to be swept down and rolled out for the annual 'widget manufacturing' school open evening!

These machines are often very time-consuming and quite difficult to learn how to use. The very idea of getting a large class of pupils to write programs and manufacture even the most basic 'widget' in six weeks seems too much to ask. If only one or two pupils at a time can work on the machines, what sort of design and make assignment can be developed? So the machines are left for yet another year or used on a one-off basis by the adventurous student on teaching practice, who just happens to have done a CAD/CAM module at college.

There is, however, a design and make assignment which has been used in schools to introduce many aspects of CAD/CAM. It also requires pupils to work in teams, which is an essential facet of a well-balanced design and technology experience. Each team has the opportunity to democratically decide upon ways of working, such as design development, division of labour and project management. The nature of the project requires each member of the team to get information from others in the team, such as logos and colour schemes, component dimensions and sizes for packaging, etc., so there must be regular team meetings.

The context/design brief set is that a games manufacturer has undertaken market research and found that many young people

Featured are a range of games which have been produced by teams of student teachers at Leeds Metropolitan University. A broad range of themes for the games were used, which could also be linked with other curriculum areas such as English and geography.

'Pooh's Quest', a children's story, (showing a basic approach to the project)

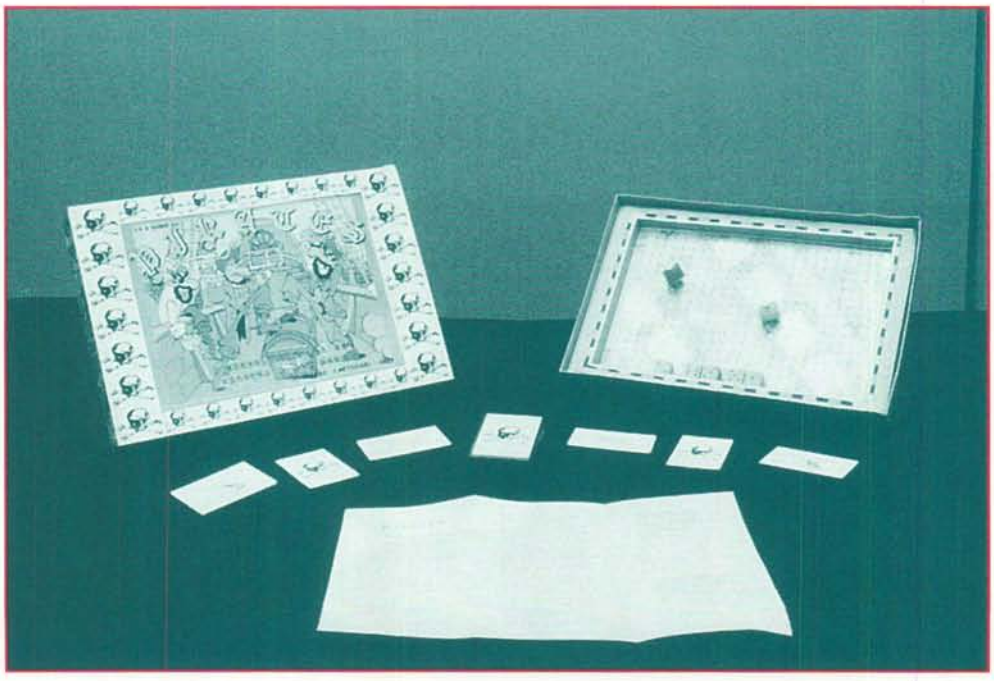
would like a travel board game to keep them occupied in cars, on trains, boats and planes. The project is suitable for the application of as little or as much computer technology as may be available in the secondary school. The following description provides ways of using the computer and conventional methods (in brackets) to arrive at the same end product. It should therefore be possible to pick and mix the aspects that can be covered taking into account facilities available and staff expertise.

A range of focused practical tasks can be used to develop skills. These can range from design development and graphic techniques through to materials and machinery usage and craft skills development. Where a large IT facility is available in the school, this could be booked and all pupils given tuition on the use of word processing, graphics/paint packages, desktop publishing and drafting/drawing software with their associated peripherals (or traditional alternatives).

To begin this design and make assignment, pupils are placed in teams and are required to identify a target age group of children who would like a travel board game. Research information can be developed through a word processed (or handwritten) questionnaire which should identify the target group's requirements, together with an analysis of the suitability of existing board games in relation to these requirements. They should then research possible themes and develop a range of designs for travel games for two players. The team should evaluate each team member's design proposals, democratically deciding on the most appropriate idea to be developed and manufactured in the time available using the range of CAD/CAM or traditional facilities available.

Each 'design team' also has to democratically decide upon which of the following manufacturing responsibilities are undertaken by each team member for specific parts of the project.

Two similar counters are manufactured from round bar on a CNC (or traditional) lathe. One can be aluminium and one brass, or two totally different profiles can be made out of the same material if two pupils are involved. Each counter is designed with a standard size spigot which fits holes drilled/milled into a clear acrylic sheet. The size of the spigot, and therefore the holes, can be predetermined by the teacher. If a CNC program has to be written, the teacher could provide the 'tool change', turning/parting sequence to be added to the end of the pupils' part program for their individual counter profile design. The holes in the acrylic sheet can be produced on a



'Pirates', (a little more detailed with cardboard inner construction).

CNC milling machine (or pillar drill). It is important to calculate the maximum size of a print from the colour ink jet printer, as the game board design should be produced using a print from a graphics/painting software package.

A range of grids on which pupils may base their board game designs may be provided by the teacher, using the same software. These should match the size and location of holes in the drilled acrylic sheet, which will cover and protect it. If a computer graphics illustration of the chosen game board is not possible, it may be a traditionally hand drawn and rendered illustration. A scanner could also be used to transfer line drawings and tracings done by hand onto the computer screen to be colour filled using painting software. Working from standard grids and dimensions given, a compendium of games can be produced with different themes developed by a number of team members. This is a way of utilising a block booking of a large IT facility. Each board game graphic can be 'stacked' under the acrylic sheet and brought to the top of the pile to play.

The games illustration with the acrylic board over is placed inside the bottom of a computer generated net/box development for the game, using a drawing/drafting software package on a computer with a plotter (or a box development 'net' drawing on a conventional drawing board). The card box could have additional features built inside in card, such as storage for counters, dice and game cards.

Computer generated illustrations, graphics and text can be produced for the outside of the box. These can then be glued onto the outside of the box to form suitable packaging for the game. Game cards and a set of rules for the game can be produced using a word processor and illustrated using a drawing or painting package. If required, they can be imported into a DTP (desktop publishing) package for layout and printed via a laser printer (or hand printed lettering, drawing and rendered illustrations). Covering or laminating the lid of the packaging, rules and game cards with clear plastic can produce a more professional finish.

This project can be extended by developing moulds for vacuum forming more sophisticated board game structures. Electronic dice with analogue or digital displays could be developed for the game and therefore the vacuum forming could include provision for these together with storage of counters or conventional dice/spinners. The development of a point of sale display for a toy shop could also be undertaken together with marketing strategies.

'Travel Tag', a geographical game (including vacuum forming with compartments for counters, dice and game cards).

Appendix 1 – Unit of work:
Travel Mate – Project overview
Time allocation: 16 hrs
Key Stage 3/Year 9
Resistant materials/CAD/CAM

The following project may incorporate of as little or as much computer technology and applications as are available in the secondary school.

The context

The activity focuses on the development of a travel game for two players which can be used in transit and is appropriately packaged. The rules are based loosely on the principles of 'Snakes and ladders'.

The activity

This focuses on game board design, packaging, CNC manufacture, computer graphics, computer assisted drafting, desktop publishing, packaging.

Starting points

- Brainstorm the essential and desirable factors for travel games for young people
- Collection of images of cartoon characters, pop music heroes, ecological issues or any suitable potential themes of interest to young people
- Analysis of existing board games, deriving suitable evaluation criteria
- Demonstrate use of image scanner using line drawings of possible characters

  or

  Demonstrate simple line drawings of theme characters
- Demonstrate CAD drafting software and plotter

  or

  Demonstrate traditional drafting of box developments on a drawing board
- Demonstrate painting software for colour filling of drawn or scanned images

  or

  Demonstrate traditional rendering techniques of line drawings
- Demonstrate use of DTP software, cut and paste text and image

  or

  Demonstrate traditional graphic lettering, composition and paste up techniques
- Demonstrate CNC lathe to produce game counters in brass/aluminium

  or

  Demonstrate use of a traditional centre lathe
- Demonstrate CNC milling machine to mill holes in clear acrylic

  or
- Demonstrate traditional milling machine or pillar drill

Key experiences

Pupils will have developed knowledge and understanding about:

- working in teams
- designing – identifying sources of information, designing for young people, market research, planning, evaluating
- computer aided design and computer assisted manufacture
- application of computer peripherals
- graphics communication – rendering, lettering use of colour presentation and layout
- use of clear acrylic sheet, aluminium / brass bar, paper, card
- designing – planning
- net/box development
- working materials
- production methods/materials

Extension activities

- moulds for vacuum forming more sophisticated board game structures, storage of counters

- dice/spinner
- electronic dice, digital display, etc.
- point of sale display for a toy shop
- consider implications of batch production
- development and analysis of people's evaluation of finished games using questionnaires, data handling, spreadsheets

Curricular links

Mathematics – scale drawing, grids, geometry, incremental/absolute measurement
Art – aesthetics, colour theory, computer painting software
English – communication, group dynamics, writing rules, possible themes based on stories

Key vocabulary

- computer numerically controlled
- computer aided design
- computer assisted manufacture
- computer graphics
- computer assisted drafting

Resources

- design brief / stimulus sheet
- graphic equipment including pencils, rulers, markers, pastels, fixing agents
- clear acrylic sheet
- aluminium and brass round bar
- A2 coloured card
- CAD/CAM computer facilities, plotter, printer

Management and organisation of learning

Programmes of Study focus

3 Designing skills

a identify appropriate sources of information that will help with their designing

d consider the needs and values of intended users, and develop criteria for their design to guide thinking and form a basis for evaluation

e generate design proposals that match stated design criteria, and modify proposals to improve them

i take account of the restrictions imposed by the capacities and limitations of tools and equipment

j explore, develop and communicate their design ideas by modelling their ideas in an increasing variety of ways, including the use of IT

l evaluate their design ideas as these develop, bearing in mind the users and the purposes for which the product is intended, and indicate ways of improving their ideas.

4 Making skills

a use a range of processes to shape and form materials

c choose and use appropriate methods

h make products in quantity, using techniques to ensure consistency

j evaluate their products as these develop, including testing performance against specified criteria

k implement improvements they have identified and take ongoing action to ensure that their products meet the specification and their original intentions

Knowledge and understanding

Pupils should be taught:

5 Materials and components

a properties

b material classification

6 Systems and control

f the importance of feedback, and how it can be used to ensure the correct functioning of mechanical, electrical or electronic systems

g to analyse the performance of systems, in order to check that they are working effectively

8 Products and applications

a intended purpose

b choice of materials/components

e views of users and manufacturers

f range of alternative products

9 Quality

a how far it meets a clear need

b fitness for purpose

c appropriate use of resources

10 Health and safety

a recognise hazards

b assess risks

c take action to control risks

Investigative, disassembly and evaluative activities (IDEAs)

- through brainstorming and discussion identify a target group of young people who would like a travel board game.
- investigate the essential and desirable requirements for travel board games
- investigate the range of games already available
- evaluate the effectiveness of these games in terms of enjoyment, interest time, features, fun, appeal, ease of use, safety aspects
- evaluate the production methods and materials of existing games
- evaluate the packaging used for these games

Focused practical tasks (FPTs)

- develop a computer generated graphic image of a theme character suitable for a travel game
- draw a box development using conventional or computer drafting facilities onto card
- practise cutting, scoring, bending and gluing the card to form a simple box
- develop rendered graphics and text using conventional methods or graphics/painting software
- use a conventional or computer numerically controlled lathe for simple turning and parting operations
- use hegner and sanding disc to cut and shape acrylic sheet safely
- use or basic hand tools for shaping acrylic sheet
- use pillar drill or CNC milling machine for drilling holes in acrylic sheet

Design and make assignments (DMAs)

- As a member of a design team, design and make a game suitable for use by two young people on a journey
- The task could incorporate batch production

Opportunities for IT

- DTP, graphics/art packages for game, box and rules
- Drawing/drafting package for box/net development
- CAD/CAM lathe for counters, milling machine for holes in acrylic board

Assessment

Each individual in a team will be required to submit the following in a project folio for assessment:

- research sheets analysing existing board games for young people
- a wide range of design sketches of ideas for different themes for travel games
- a series of designs for the specific components which they intend to produce (e.g. counter profiles, acrylic grid layout, graphic illustrations, packaging, etc.
- working drawings, CNC programs, net/box developments
- evaluation by the target users, suggestions for improvements
- each individual's work should be clearly labelled and identifiable.