Rewarding Learning

AS LEVEL Section D

FACT FILES

Technology & Design

For first teaching from September 2011

For first award in Summer 2012

Designing Part 2

technology and design

FACT FILE

1.27 Designing Part 2

technology and design

Learning Outcomes

Students should be able to:

- Demonstrate knowledge and understanding of the Design Process including:
  - generation of ideas - thought showers, lateral thinking attribute analysis, SCAMPER and inversion and their use to produce innovative design solutions;
  - development and refinement of ideas;
  - modelling.

Course Content

Generating Ideas

Exploring a design brief and gathering information will hopefully leave your mind full of possibilities and avenues which you might pursue. It is particularly important to keep a log book which records ideas and the project's progress during these early stages.

If you have written your design specification carefully, and become aware of all the requirements, you will probably see that there are several potentially viable ideas but many of the possibilities lead nowhere.

If you have no ideas left to pursue it is necessary to generate some, and the techniques described in this fact sheet have been developed to help you.

All designers hope that they will have a sudden 'Eureka!' moment when the design solution becomes apparent. Thought showers, attribute analysis, SCAMPER and inversion can make such insight more likely.


Lifesize/Thinkstock

Thought Showers

This group creativity technique is designed to rapidly generate a large number of ideas to the solution of a specific issue or problem. Other people may see aspects of a problem which the designer has overlooked. The more disparate the backgrounds of the participants the more likely it is that they will bring a different view. Open-plan areas which allow free discussions with colleagues are the ideal environment for good design.

The term 'thought shower' was coined in the early 2000s as an alternative to the term 'brainstorming'. This technique originated in the advertising industry where Alex Osborn formulated some simple rules:

- no criticism of any idea is allowed – judgement is withheld until later;
- all ideas are welcomed, no matter how bizarre they may appear;
- the emphasis is to produce a large number of ideas; and
- building on someone else's idea to create a group chain reaction is encouraged.


Stockbyte/Thinkstock

Following these rules creates a relaxed environment in which people are not inhibited and can therefore think freely and adventurously. Some experiments conducted to confirm the effect of thought showers seemed to indicate that they do not generate any more ideas than people working individually and then pooling their thoughts and the outcome depends on how the sessions are organised.

It helps if the following conditions can be met:

- advance notice should be given of the problem so that people can 'tune in' to it;
- a balanced team of about twelve should be formed under a firm, experienced leader;
- a reporter should be appointed to record all ideas; and
- too wide a difference in the status of the group members should be avoided as this tends to inhibit free expression.


Lifesize/Thinkstock

Thought showers are one of the most widely used techniques for generating ideas, but clearly there will be a lot of analysis required to assess the potential of each concept. When the number of alternatives is restricted, thought showers are unlikely to produce much progress and a more forceful technique, such as lateral thinking, may provide the answer.

Lateral Thinking

Primary research involves collecting information yourself, from various sources, including:

- direct contact with experts;
- communication with a client or user;
- fieldwork – physically collecting data;
- questionnaires which are carefully constructed and offered to representative sample groups;
- exhibitions and displays;
- testing and experimentation; and
- modelling and computer simulations.

The term 'lateral thinking' was coined by Edward de Bono in his book "New Think: The Use of Lateral Thinking" published in 1967.

De Bono chose the term 'lateral thinking' to distinguish it from what is perhaps the traditional or conventional form – vertical thinking. De Bono said, "Lateral thinking is for generating ideas, logical thinking is for developing, selecting and using them."

The principles of lateral thinking can be divided into four areas:

- the recognition of dominant, polarising ideas;
- the search for different ways of looking at things;
- a relaxation of the rigid logical control associated with vertical thinking; and
- the use of chance.

Some of the techniques are described below:

Dominant ideas – When thinking about a problem, especially a complex one, you must free your mind from rigid patterns of thinking. You should recognise what ideas dominate your thoughts. These will not necessarily be the same as those which dominate the thinking of others.

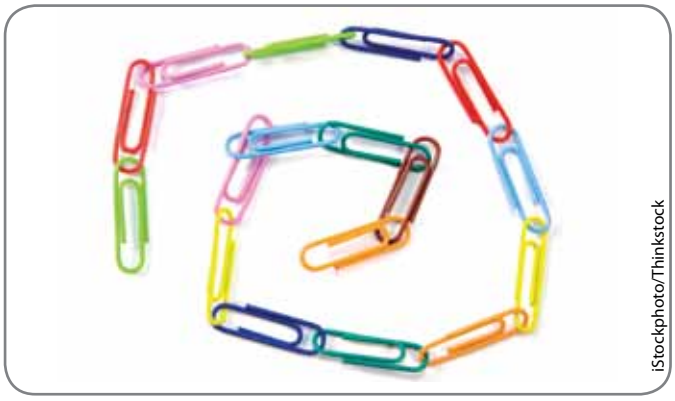
Looking at things differently – line drawings, diagrams, graphs, charts and colour can all be used to explore relationships between aspects of a design, and this is, of course, exactly what designers try to do when exploring their ideas on design sheets.


Lifesize/Thinkstock

Escaping from vertical logic – vertical thinking depends on each step along a path of reasoning being correct, but it is only necessary to be correct at the end. A good solution or idea remains good no matter how it is arrived at.

The introduction of random words to force connections and find unusual analogies is one technique through which a search can be pursued.

Using chance – you cannot make things happen by chance, but you can allow chance to play its part. Designers can allow chance to play its part by wandering through exhibitions or shops and absorbing indiscriminately all the stimulating aspects of the environment. De Bono uses the analogy of a chain of paper clips carefully made by attaching each one to another. He then points out that a chain can also be formed by opening out a large number of paper clips and tossing them about in a pan. If they are tossed long enough they will form a chain – they will have organised themselves into a pattern which is original and unexpected. The interaction of new information and stimulants to give new patterns work in much the same way – they need to be numerous and not contained in tight, rigid groups.



iStockphoto/Thinkstock

Attribute Analysis or Morphological Analysis

Attribute Analysis or Morphological Analysis is a very straightforward technique to apply and follows quite naturally from the detailed product analysis of currently available products. Its mechanistic nature can be regarded as beneficial because it avoids personal blind spots which can result from habit, familiarity or prejudice.

The attributes or characteristics of a design can be written down in the form of a table or matrix. The simple act of listing the attribute in a matrix generates many more possibilities. Some of these can be strange or impossible, some will represent existing designs, but others can be quite thought-provoking. Having listed the attributes, it is usually not too hard to expand the options; for example, different material possibilities can be added.

Attribute analysis is sometimes described as a 'smashing' technique, because it 'smashes' our preconceived ideas about a product or idea. Attribute analysis is often another way of recognising that a given problem is really a collection of interrelated smaller problems. It is a method of seeing the variables that create a situation in a way that allows us to change one or more of these and therefore improve a design.

Examples of attributes are:

- physical – colour, weight, material, structure, size, form
- functional – intended uses, applications, how does it work?
- user – who will use it?
- psychological – appearance, aesthetics, design semantics, how do you react emotionally to the product?

This technique therefore, is a very thorough way of generating ideas.

SCAMPER

SCAMPER is based on the theory that everything new is actually a modification of something that already exists. Each letter in the acronym represents a different way that you can play with the characteristics of what is challenging you, to trigger new ideas:

- S – substitute
- C – combine
- A – adapt
- M – magnify
- P – put to other uses
- E – eliminate
- R – rearrange

To use the SCAMPER technique, first describe the product you wish to design. After pinpointing the challenge, it is then a matter of asking questions using the SCAMPER checklist.

Substitute – think about replacing part of the problem with something else. By looking for replacements you can often come up with new ideas. You can change things, people, places, ideas or even emotions. Some helper questions are:

- Can I replace or change parts?
- Can I use other materials?
- Can I use other processes or procedures?

Lifesize/Thinkstock

Combine – think about combining two or more parts of your problem to create a different product or to enhance their synergy. A great deal of creative thinking involves combining previously unrelated ideas to create something new. Some helper questions are:

- What ideas or parts can be combined?
- Can I combine it with other objects?
- What can be combined to maximize the number of uses?


iStockphoto/Thinkstock

Adapt - think about adapting an existing idea to solve your problem. To some extent all new inventions are borrowed. Some helper questions are:

- Is there something similar to it, but in a different context?
- Does the past offer any lessons with similar ideas?
- What ideas could I incorporate?


Polka Dot/Thinkstock

Magnify - Magnifying your idea, or parts of it, may increase its perceived value or give you new insights about what components are most important. Some helper questions are:

- What can be magnified or made larger?
- What can be exaggerated?
- Can I add extra features or somehow add extra value?


iStockphoto/Thinkstock

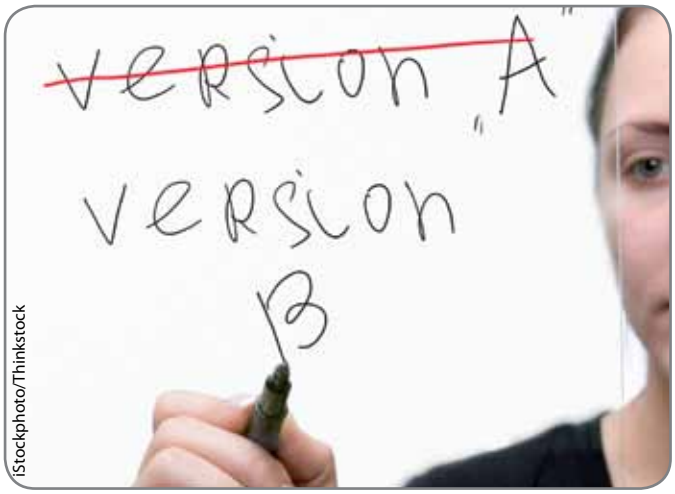
Put to other uses - think of how much you might be able to put your current idea to other uses. Many times, an idea only becomes great when applied differently than first imagined. Some helper questions are:

- What else can it be used for?
- How would a child or old person use it?
- If I knew nothing about it, could I work out what it was for?

iStockphoto/Thinkstock

Eliminate - Simplify, reduce or eliminate components. Through repeated trimming of ideas, objects and processes you can gradually narrow your challenge down to that part or function that is most important. Some helper questions are:

- What can be removed without altering its function?
- What is non-essential?
- Can I make it more compact?



iStockphoto/Thinkstock

Rearrange (or reverse) - think of what you would do if part of your product worked in reverse or were in a different order. Concentrate on ways to make a product or system less effective and the invert these ideas to form ways in which the product can be improved. Some helper questions are:

- Can I transpose cause and effect?
- Can I transpose positives and negatives?
- Should I turn it around or upside down?


Photos.com/Thinkstock

Below are two examples of how *inversion* was applied in the design of products:

Computer printer – the original computer printer was a typewriter, with a mechanism attached to it that would strike keys on activation by the computer. The problem was that the mechanism was working so fast to keep up with the output from the computer that the inertia of the typewriter keys themselves made the hammers strike one-another and get stuck. Additionally, the carriage, which carried the paper, could not perform a 'carriage return' quickly enough to match the speed with which the computer operated.


Hemera/Thinkstock

In this case, inversion was applied by utilising small, light print heads that have little inertia and that can be made to move across the paper very quickly. The carriage no longer does carriage returns; it is the print head that provides this function. The problem was inverted by making the object that moved stationary, and that the object that was stationary move.

Heavy Vehicle Brakes – a long time ago, breaks for heavy vehicles were normally released and pressing the brake pedal engaged them. This is obvious and intuitive and is how brakes function on cars. However, there was a problem: when the brakes failed, the vehicles would lose control. For a very heavy vehicle this had the potential for catastrophic consequences.

The solution was to invert the problem. In modern braking systems, the brakes are not engaged unless the engine is running and all pressure sensors indicate nominal operation. In this case, when the vehicle is operating normally, the brakes are forced to release by hydraulic or pneumatic mechanisms. If there is a failure of the braking system, the brakes will automatically engage, stopping the vehicle.


Stockbyte/Thinkstock

Development and Refinement Of Ideas

In describing the phases which occur within different design stages, three elements can be identified: divergence, transformation and convergence. At the start you must concentrate on generating ideas and conceptual approaches. However, there is a time when you must begin the process of evaluating what has been developed, bringing together the key features and resolving conflicts.


Hemera/Thinkstock

Design Development

Once a design has been generated, a period of concentrated development must follow. Commonly, two or more concepts will be developed alongside each other at this stage, sometimes, depending on the scale of the project, with a different sub-team responsible for each concept. The purpose of this is to explore the potential in a concept. It is not usually possible to know how feasible, how attractive, or how functional an initial design concept is until its limits have been explored. By no means the least important aspect of this is the gradual increase in the quality at which models are produced, from initial sketches and outline 'concept models' to large scale, detailed mock-ups.

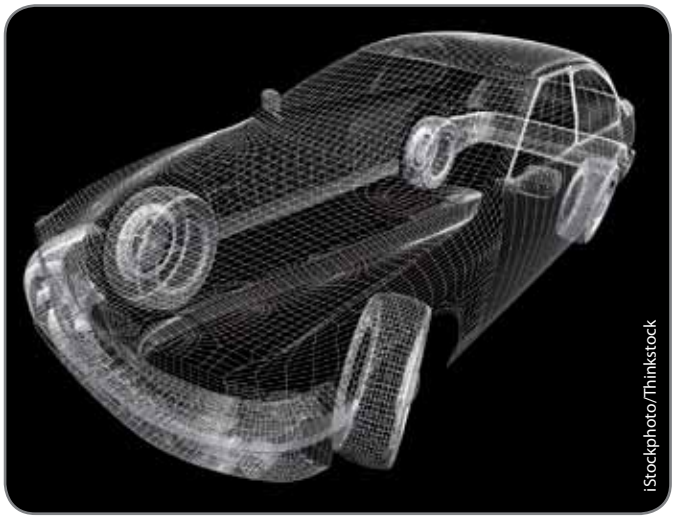
At this stage the designer will:

- Start to detail the specifications, prioritising needs and requirements of both the customer and manufacturer;
- Consider ergonomic, aesthetic and functional requirements;
- Check design ideas and develop them to meet these requirements;
- Model ideas;
- Identify and take account of some production parameters, such as the quantity of products to be manufactured;
- Identify and take account of some production process constraints, such as sustainability and availability of resources; and
- Check the likely cost implications.


Stockbyte/Thinkstock

Modelling

Modelling should be used to test features such as proportions, scale, function, sub-systems, and so on. Modelling can be achieved through the use of traditional materials, or 2D and/or 3D computer simulations.



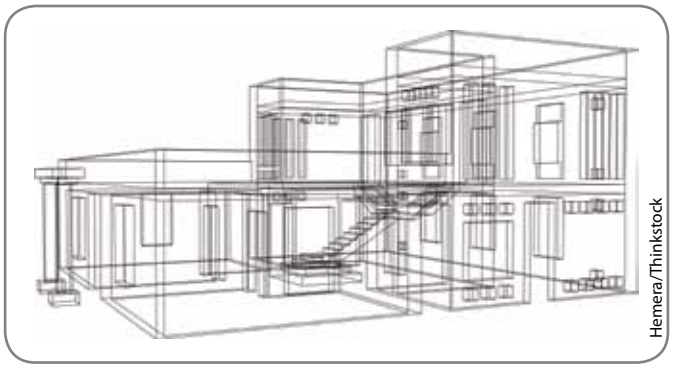
Graphical Modelling

Graphical techniques are used in the early stages of a design to record information and ideas that are perceived to be relevant. During the divergent and speculative phases, drawings are used to help concepts develop, by giving them a concrete form which provides an image for the mind to work on.

Design sheets form an effective record for the designer and for the communication of their thinking to others. When the process as well as the product is being assessed it is essential that all the key stages are adequately recorded. In the later stages as thoughts converge, more precise graphical models such as measured drawings are used to communicate the product.

Pictorial Drawings

Isometric, planometric (axonometric), oblique and perspective drawings to convey a 3D representation of the product.



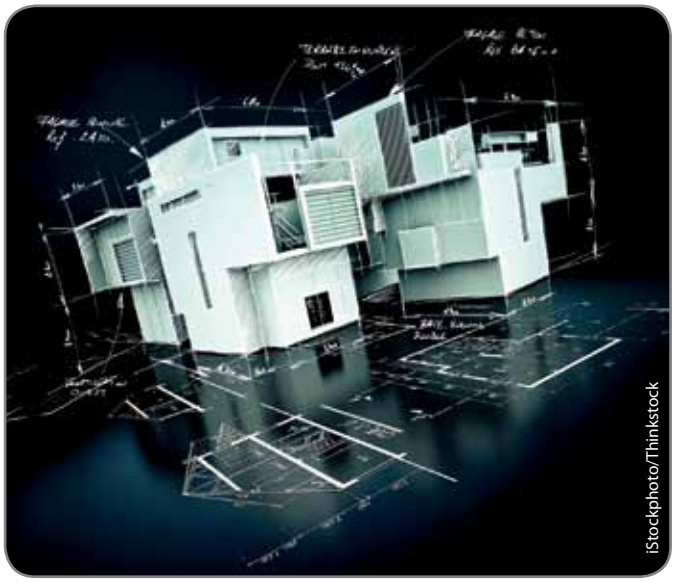
Working Drawings

A working drawing is the final technical drawing produced by the designer as part of the design process. These drawings normally consist of the following views:

- Front;
- Side; and
- Plan working drawings are always drawn to scale.

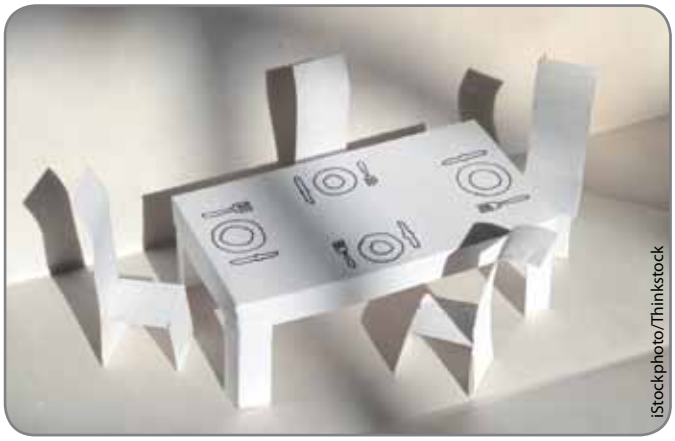
Computer generated drawings

CAD-CAM systems have been developed to allow highly sophisticated design modelling which can simulate the product in use and in production processes. CAD can also be used to generate pictorial and working drawings.



Physical Modelling

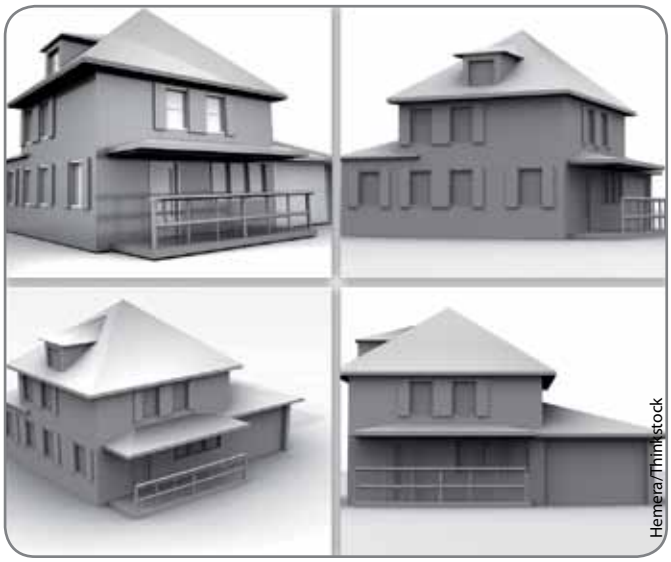
Physical Modelling concerns the making of a limited three-dimensional representation of a product or system in order to reveal particular information about it. It is as relevant in the early stages as in the later stages.



iStockphoto/Thinkstock

Rapid Prototyping

Rapid prototypes are physical models that are generated directly from a CAD system. They can be used to produce working prototypes of the product or the tooling for castings.



Hemera/Thinkstock

Rapid prototyping is becoming more important for designers. The development of concurrent engineering (or simultaneous engineering) has been the result of pressures to reduce product lead times. With product life-cycles and, consequently, product development times becoming ever shorter, it is essential for the design process to accelerate.

Revision questions

1. In an attempt to generate ideas the designer can use a range of creativity techniques.
   (i) Identify **two** creativity techniques commonly used by designers.
   (ii) Briefly outline **two** main characteristics for each of the two creativity techniques identified in part (i).

2. Designers use creativity techniques and employ a range of entrepreneurial and team working skills.
   (i) Briefly outline **two** creativity techniques commonly used by designers.
   (ii) Briefly outline what is meant by the term entrepreneurial skills.
   (iii) Briefly outline what is meant by the term collaborative skills.

3. Describe the various types of modelling used in the development of a new product and explain their advantages.

COUNCIL FOR THE CURRICULUM EXAMINATIONS AND ASSESSMENT
29 Clarendon Road, Clarendon Dock, Belfast BT1 3BG
✆ +44 (0)28 9026 1200 +44 (0)28 9026 1234 +44 (0)28 9024 2063 info@ccea.org.uk www.ccea.org.uk
Rewarding Learning