Graphics

What Is the Study of Graphics About?

Graphics is a subject that engages students in purposeful study of drawing and design and challenges them to develop and communicate design ideas.

Graphics connects strongly to the technology learning area and supports a particular form of technological practice that employs visual communication knowledge and techniques to develop conceptual designs or technological outcomes of a graphical nature.

Rationale

Why Study Graphics?

The study of graphics enables students to conceptualise, develop, and communicate design ideas and potential outcomes, and provides them with skills to interpret and communicate visual information in other learning areas.

The growing role of visual communication within contemporary society demands that students develop their ability to interact critically with and interpret visual messages. Students who develop this ability, together with an understanding of design, will be better able to recognise and predict the potential future influences on, and impacts of, visual communication and design in their own and others' graphics practice and outcomes. Future focus is one of the principles encouraged by *The New Zealand Curriculum* (page 9).

Developing an ability to interpret and critique the range of visual codes "in which knowledge is expressed" strengthens the key competency using language, symbols, and texts (*The New Zealand Curriculum*, page 12).

The development of intellectual and practical ability in graphics also relies on and contributes to developing the key compentency of thinking, particularly the creative and critical thinking skills. Students studying drawing and design and undertaking graphics practice gain knowledge and skills that enhance their ability to visualise, reason, and make informed decisions.

Concepts

Conceptual Understandings in Graphics

Teachers need to provide their students with frameworks so that they can build on conceptual understandings to develop ways of structuring their own understandings.

Students' learning is enhanced when teaching and learning is structured around multiple and timely approaches to conceptual understanding. For students to understand the breadth of graphics concepts and develop deep conceptual understandings, they need:

- time to explore conceptual understandings in depth;
- opportunities to approach the understandings in different ways through many perspectives;
- opportunities to re-visit understandings in a number of contexts,

Looking for progression in conceptual understandings

Graphics students at curriculum levels 6, 7, and 8 may progress the same understandings at different levels. The development of these conceptual understandings is cumulative. As students return to familiar graphics understandings in different contexts throughout their learning, they gradually increase the breadth and depth of their understanding. This supports the student's ability to recognise the same understanding in multiple contexts. Teachers can see that students' conceptual understandings have progressed when:

- their level of understanding increases;
- they make connections between conceptual understandings;
- they apply and transfer their understandings to more complex and distant contexts, as well as to those that are familiar;
- they take responsible actions and make informed decisions that are based on their new understandings.

Pedagogy

Approaches to Teaching Graphics

Pedagogy means teaching practice – what teachers do – and the ways in which their programmes enable their actions and affect student learning.

There is more than one approach to teaching graphics. Effective teachers use a combination of approaches and strategies to support student learning in graphics. Teaching graphics includes building student knowledge together with developing their skills and practices.

Effective teaching practice will provide a variety of opportunities for students to develop their learning so that they become aware of what they know and can confidently select and apply their knowledge, skills, and practices in new situations.

Teachers need to differentiate their teaching to meet the needs of individual students and select relevant and meaningful contexts that will engage their diverse students.

Breadth in graphics practice

It is important that students experience a wide range of contexts within their graphics practice. The terms spatial design and product design allow for a wide interpretation of design practice:

- ***Spatial design*** could include architectural, interior, and landscape conceptual design.
- ***Product design*** could include such areas of design as fashion, packaging, and media products and technological and engineering conceptual design.

The mechanisms and approaches that facilitate learning in graphics

Key approaches to teaching are outlined in the section Effective Pedagogy of *The New Zealand Curriculum* (pages 34–36).

Some of the ways in which such approaches specifically enhance learning in graphics are set out below.

Creating a supportive graphics learning environment

In the graphics classroom, teachers will:

- create a rich, stimulating environment featuring students' work, products of designers and manufacturers, and examples of designer practice;
- ensure a wide range of resources are available to encourage and support student experimentation, exploration, communication, and development of design ideas;
- offer challenging, creative, useful, and enjoyable design and drawing experiences that are relevant to students' diverse interests and cultural backgrounds;
- support knowledge of technologies and their applications;
- promote awareness of economic and environmental issues and encourage the exercising of aesthetic values and sustainable practices;
- encourage students to carry out informed and critical discussion and debate with other students, teachers, and the wider community;
- give students a range of opportunities to seek information and consider alternative possibilities in graphics, in order to maximise the success of individual and collaborative activities and/or practices;
- give students a range of opportunities to access understandings from professional graphic practitioners such as graphic designers, architects, interior designers, and landscape designers.

General information about how to construct a supportive learning environment can be found in the section Effective Pedagogy (page 34) of *The New Zealand Curriculum.* An environment in which the teacher builds respectful relationships with their students is essential for all students.

Encouraging reflective thought and action

In a graphics classroom, teachers will encourage students to:

- examine the products and systems developed by a range of designers and manufacturers to gain an understanding of the elements of good or poor design;
- consider where developments in the area of design ideas and graphical outcomes might lead to in the future;

- consider the practice of past designers to gain a historical design perspective;
- analyse their own developing solutions based on the principles and elements of design, in order to refine and develop alternative design ideas;
- develop their knowledge of materials, processes, and components to meet design needs;
- understand and use appropriate technical language;
- be aware that modelled solutions are used to communicate the design features of a potential solution;
- understand the socially embedded nature of design: people affect design – design affects people.

Graphics teachers can also foster intuitive responses to design ideas. They can support students in creative risk-taking for innovation and encourage them to use ambiguity to explore ideas, when:

- testing, trialling, or modelling design ideas;
- resolving design problems through reasoning in order to make judgments;
- developing design awareness by analysing existing solutions in terms of the principles and elements of design.

Enhancing the relevance of new learning

In a graphics classroom, teachers will:

- make deliberate connections to prior learning and student experience to ensure new learning is effective;
- support students to resolve design problems effectively by gathering information and, in many cases, by learning new skills and acquring further knowledge;
- provide opportunities for students to gain insights into how other people have resolved similar problems in the past;

- ensure a balance between "just in time" and "just in case" learning and depth and breadth in students' learning experiences;
- provide sufficient opportunities for students to build their repertoire of knowledge, skills, and practices in contexts that are authentic and relevant to them.

Teaching as inquiry

The New Zealand Curriculum describes a process for "teaching as inquiry", on pages 34–36. This cyclical process, which is outlined on page 35, provides a framework that can help teachers to plan strategically and to notice (and respond to) the effects of their teaching.

E-learning and pedagogy

Information and communication technologies (ICTs) have become central in our lives in both work and leisure. They play a significant role in schools, where they contribute towards a student's contemporary education and provide insight for them into a variety of career opportunities. As new ICTs are developed, they dramatically influence the design industries in the methods they use to develop and communicate graphics. This influence should be recognised in the teaching and learning of graphics within general education.

Using ICTs affords students many opportunities to gain practical computing experience and to develop confidence and basic skills in using a range of hardware and software. This could include such ICTs as: digital cameras, word-processing packages, design and publishing software, basic CAD software, and programs for constructing web pages.

Information and communication technologies have the potential to make a significant contribution to students' learning in graphics by helping them to:

- generate, explore, model, develop, and communicate design ideas;
- enhance understandings of drawing and design through the use of:
    - computer control
    - computer-aided design

- simulation and modelling
- communications
- CD-ROM andor the Internet*.

*Note: Adapted from *Using Information and Communications Technology to Meet Teaching Objectives in Design and Technology*. London: Teacher Training Agency, n.d.

There are two central reasons for including ICT activities in graphics studies:

- to enable students to develop confidence and skills in using a variety of appropriate ICTs;
- to encourage students to view ICTs as exciting and versatile tools that can be used to solve problems; to improve standards of presentation, including communication; and to promote independent learning.

Assessment considerations

The New Zealand Curriculum notes (page 39) that "The primary purpose of assessment is to improve students' learning and teachers' teaching as both students and teachers respond to the information that it provides."

Further information on assessment can be found in the Assessment Community on Te Kete Ipurangi (TKI). For a recent overview, see *Directions for Assessment in New Zealand*, a paper by Michael Absolum, Lester Flockton, •John Hattie, •Rosemary Hipkins, and •Ian Reid (available as a Word or PDF file).

Students need to know the intended learning outcomes for the graphics programme or project that they are completing and the criteria that will indicate they have succeeded in meeting each outcome. It is important, therefore, to clarify these learning outcomes and criteria at the start of a unit of work and to provide feedback and feedforward to support student success.

Formative self-assessment and peer assessments are useful approaches, as students continue to take increasing responsibility for their own learning. Dialogue between teacher and students can help to clarify what learning has occurred and how further learning can be supported.

Assessment should be an ongoing process, through which a range of evidence is gathered to inform the next steps for teaching and learning.

The Strands and Learning Objectives

The Strands

The learning objectives for graphics are structured using two strands: **Graphics Practice** and **Drawing and Design**. These strands should be integrated to develop quality teaching and learning programmes in graphics.

The **Graphics Practice** strand focuses on the creative application of drawing and design knowledge and techniques in the development of a conceptual outcome to address a brief or a technological outcome of a graphical nature. The brief used in graphics and design may be provided to the students or developed by the students as part of their practice. Quality outcomes rely on the selection of appropriate and well-executed drawing techniques and presentation methods that allow conceptual designs to be communicated effectively.

The **Drawing and Design** strand focuses on knowledge and skills associated with increasingly sophisticated multi-dimensional drawing techniques and media usage, including understandings of relevant codes of practice, conventions, and underpinning concepts. This strand also focuses on synthesising and organising visual information for effective presentation and on gaining knowledge about design principles and approaches and the nature of design in the world.

Learning Objectives

Strand 1: Graphics Practice

Descriptor

Students will:

Level 6	**Level 7**	**Level 8**
apply drawing and design knowledge and techniques to visually communicate design ideas in the	apply drawing and design knowledge and techniques to visually communicate design ideas during the	apply drawing and design knowledge and techniques to visually communicate the ongoing development and

development of a conceptual outcome to address a brief, through the generation, testing, and evaluation of design ideas.	ongoing development and analysis of a conceptual outcome to address a brief, through informed generation, testing, and evaluation of design ideas.	critical analysis of a conceptual outcome to address a brief, through informed generation, testing, and critical evaluation of design ideas.

Teachers can provide learning opportunities based on the objectives for *Brief Development* and *Outcome Development and Evaluation* from the technology learning area in *The New Zealand Curriculum*. The outcome of graphics practice can be a prototype specifically in terms of a technological outcome of a graphical nature.

Indicators

Level 1	**Level 2**	**Level 3**
uses **Drawing and Design** knowledge in the development of a conceptual outcome that addresses a brief;	uses **Drawing and Design** knowledge to analyse and develop a conceptual outcome that addresses a brief;	selects and uses **Drawing and Design** knowledge to critically analyse and develop a conceptual outcome that addresses a brief;
undertakes research and functional modelling (testing design ideas) to gain feedback to inform the generation and development of design ideas;	analyses and undertakes appropriate research and informed functional modelling (testing design ideas) to gain relevant feedback to inform the generation and development of design ideas;	critically analyses and undertakes appropriate research and informed functional modelling (testing design ideas) to gain critical, in-depth feedback to inform the generation and development of design ideas;

selects and applies visual communication techniques and media throughout practice to develop communicative models and present a conceptual outcome;	determines suitability of visual communication techniques and media (drawing and design) and applies these throughout practice to develop communicative models and present a conceptual outcome;	justifies suitability of visual communication techniques and media (drawing and design) and applies these throughout practice to develop communicative models and present a conceptual outcome;
uses **Drawing and Design** knowledge to evaluate the potential fitness for purpose of the developing and final conceptual outcome against the brief;	uses **Drawing and Design** knowledge to evaluate the potential fitness for purpose of the developing and final conceptual outcomes against the brief and the issue the brief seeks to address;	uses **Drawing and Design** knowledge to critically evaluate the potential fitness for purpose of the developing and final conceptual outcomes against the brief, issue and wider context;
identifies potential implications of the conceptual outcome.	undertakes analysis to determine the potential implications of the outcome in terms of the issue(s) that relate to the brief and their possible influences and or impacts.	undertakes critical analysis to establish the potential implications of the outcome in terms of the issue(s) and wider context that relate to the brief, and their possible influences and or impacts.

Strand 2: Drawing and Design

Descriptors

Students will:

Level 1	Level 2	Level 3
• gain knowledge and skills in fundamental drawing techniques; • gain knowledge of visual communication and design principles and approaches and influential designers.	• gain knowledge and skills in complex drawing techniques and in presenting visual information; • gain knowledge of design heritage and specialist fields.	• gain knowledge and skills in synthesising and organising visual information for effective presentation; • gain knowledge of the nature of design.

Indicators

Level 1	Level 2	Level 3
demonstrates competency in fundamental 3D drawing techniques (e.g., oblique, isometric, and planometric, which includes freehand and/or instrumental) and associated media (e.g., drawing equipment and surfaces); demonstrates competency in fundamental 2D drawing techniques (e.g., multi-view orthographic, sectional views, surface development, and geometric construction, which includes freehand and/or instrumental) and associated media (e.g., drawing equipment and surfaces).	demonstrates competency in complex 3D drawing techniques (e.g., one- and two-point perspective projection and isometric projection, which includes freehand and/or instrumental) when drawing complex objects; demonstrates competency in complex 2D drawing techniques (e.g., auxiliary views, hidden detail, and assembly, which includes freehand and/or instrumental) when drawing complex objects.	
demonstrates knowledge of influential designers (and their practice) from New Zealand and/or international design history;	demonstrates knowledge of design heritage, i.e., describes the fundamental characteristics (such as philosophy, time and place, available technologies, and materials) that define a major design movement;	develops and justifies a view of design that describes the interactions between design and the world (this may be expressed through students' practical work and/or through their thinking);

demonstrates understandings of the two principles of design, aesthetics and function, and of their derived elements; demonstrates understandings of how drawing and annotations are key in the development of visual ideas for effective communication.	demonstrates understandings of specialist knowledge from recognised design fields; uses drawing and annotations in the presentation of visual ideas for effective communication.	demonstrates understandings of how visual communication is central to designerly thinking; presents visual information that is organised to demonstrate the synthesis of visual ideas for effective communication, e.g., design thinking, composite techniques, and levels of meaning; 2D, 3D, and 4-dimensionality.

Connections

Connections between Graphics and Other School Subjects

The study of graphics has a strong relationship with the learning area of technology. Graphics is integral to all technology programmes. Visual communication and an understanding of design supports the components of technological practice.

The strand Nature of Technology provides graphics with concepts about design as a form of human activity and builds an awareness of how developed outcomes may exist and be accepted in the made world. The strand Technological Knowledge focuses on students' understanding of modelling, material use, the development of models, and how technological systems can be developed and communicated.

The study of graphics also offers opportunities for links with mathematics, which should be explored. In particular, geometry and measurement, through geometric construction and scale, are fundamental to studying graphics.

Graphics teachers need to consider the relationships between the learning areas in order to allow students to take advantage of the knowledge and skills gained in other studies.

Developing Learning Pathways

The principle of coherence (*The New Zealand Curriculum*, page 9) states that: "The curriculum offers all students a broad education that makes links within and across learning areas, provides for coherent transitions, and opens up pathways to further learning."

Broadly speaking, this means that educators in the curriculum learning areas and senior secondary subjects need to consider:

- how students become interested in a learning area or subject;
- how they can identify a pathway through secondary school;
- how they can see where learning may take them, either into further tertiary learning or into employment.

Coherence means developing programmes of learning that are relevant and challenging for all students. At a more practical level, heads of departments or faculties and teachers need to consider and construct explicit learning pathways within the various programmes of learning. They also need to help students to identify and understand what these possible pathways are and where they could lead in the future.

This work could be done in conjunction with careers advisers and align with existing programmes for careers advice in schools.

It is important for students to be able to see for themselves where possible pathways to further learning or employment may take them. Accurate and up-to-date information should be readily available to support students in choosing and developing a particular pathway. Guidance and support for learning and career pathways is critical in a world where there is a lot of choice and where young people need to be flexible and versatile as they manage their careers. Today's students need to be prepared to have more than one career. They need the skills that will allow them to participate in the knowledge economy.

School teachers, careers educators, and senior management teams need to work together with families to support students in making informed decisions about their future study and career options.

The ultimate goal of career education is for students to develop the understandings, skills, and attitudes that they need to make positive, informed career decisions throughout their lives. These understandings, skills, and attitudes are directly linked to the key competencies, in particular managing self, participating and contributing, and relating to others. Developing and reviewing suitable education or pathway plans is an important way in which students can develop and apply these competencies in a lifelong context.

Involvement in learning activities in graphics and/or design communities of practice connects students to mentors and develops their understandings of possible careers.

Graphics provides a foundational platform of skills and knowledge for a career in the creative industries.

Some students may pursue further studies in graphics and design-related programmes at tertiary institutions.

Learning Programme Design

Setting Up Graphics Programmes

To set up an effective graphics programme in their school, teachers need to establish a supportive learning environment, decide on an appropriate structure for the programme, and consider the key elements needed in a graphics programme at each level. A well-designed programme will enable teachers to meet the needs and interests of their students, using appropriate instructional strategies and learning and assessment opportunities.

The key competencies, values, and principles described on pages 9–13 of *The New Zealand Curriculum* are the essential broad curriculum requirements that teachers need to address when designing the school's graphics programme. Teachers will build on the potential of graphics to support the wider curriculum, including all five key competencies.

The study of graphics begins, as part of the technology curriculum, at year 1. Basic concepts of drawing, and graphic communication as a vehicle for problem-solving activities, can be effectively introduced at this level. Students' knowledge and skills in drawing and graphics are expected to be developed as an integral part of their technology education from year 1 onwards.

What are the components of an effective graphics programme?

An effective graphics programme will challenge students to develop their abilities to learn and work independently and successfully. Graphics programmes at all levels should provide students with practical experiences of working in groups, sharing responsibility and decision making, and learning to create good working relationships. The inclusion of graphic communication activities that require individual interpretation will encourage students to take responsibility for their decisions and to use initiative, determination, and self-reliance.

Through varied and realistic assignments involving design, drawing, modelling, testing, and evaluation, students learn to identify and address real problems. These experiences will enable them to become confident and knowledgeable in their response to technological, environmental, and social change. In this context, they can be encouraged to develop values of objectivity, commitment, self-esteem, sensitivity, and consideration for others and their needs.

Through seeking out and selecting information, developing design ideas, and evaluating their own work and that of others, students should become more discerning as consumers, as well as increasingly concerned for design and manufacture as it affects the quality of life and the environment.

Including design objectives in graphics programmes is both educationally and vocationally very important. Because design activities develop the ability to reason and make judgments, they are increasingly recognised for their contribution to intellectual development. The objectives that relate to design provide many opportunities for students to exercise their imagination and critical faculties. The disciplined application of design experience to solving real problems develops these vital thinking skills.

Design activities should motivate and stimulate students to search for different solutions, to introduce individual ideas with confidence, and to develop their own graphic interpretations with skill and flair. Such opportunities will occur throughout graphics practice, which involves students in identifying, investigating, and analysing problems and in generating, developing, and evaluating solutions.

The varied problem-solving activities in graphics demand an understanding of the basic principles and elements of design combined with a knowledge of the forms of illustration and modelling needed to express these ideas.

The successful inclusion of design activities in a programme demands careful consideration and planning. Students must acquire the skills and experience they need to successfully solve the problems posed by the brief. Teachers need to identify these needs when planning a graphics or technology programme. Appropriate skills and knowledge can then be introduced progressively in a natural and effective way as the programme progresses.

Throughout a programme, students should be actively encouraged to utilise knowledge and skills gained in other areas of the curriculum to help in solving problems, supporting design ideas, and improving the quality of results.

Good presentation demands a variety of skills in different media and an ability to apply these techniques with a degree of individual flair. In graphics (as in any technology programme) students should be encouraged to aim at high presentation standards. Teachers must continue to provide leadership and sound guidance through demonstration, example, and the provision of suitable resources.

Being able to produce quality presentations plays a vital role in successfully developing and marketing a new product or idea. A poorly presented design is unlikely to be appreciated, understood, or accepted. Students are expected to assemble a well-presented folio of work that shows evidence of their graphic skills and knowledge when applying for tertiary study or a career opportunity in an associated field.

Before students can effectively solve design problems, they must gather information and, in many cases, learn new skills and knowledge. Students need to gain some understanding of how other people have solved similar problems in the past. Examining the actual products of designers and manufacturers helps students to gain a better understanding of the elements of good design. Students will readily identify good and unsound features when considering the functional requirements and, with guidance, will also begin to appreciate the stylistic, aesthetic, material properties and environmental factors that often determine the success of a product or system.

It is particularly important in graphics that students are enabled to examine objectively the various aspects of their work and identify improvements or alternative possibilities. Evaluation needs to be an ongoing student responsibility and should not be confused with teacher assessment or the award of grades or marks.

Evaluation is a vital component in the process of design. In this context, students are required to judge their designs in terms of how effectively their developing solution addresses the specifications of the brief. Given encouragement, students respond positively to this challenge. They learn how to identify faults and make changes throughout a design process. This is reflected in improved results and confidence.

Evaluation procedures should be encouraging, informative, and helpful to students. Discussion and consultation should be promoted. Evaluation should enable students to consciously think about their decisions and practices and should prepare them to examine other possibilities in pursuit of a more imaginative or otherwise superior solution.

At senior levels, students should be responsible for writing the brief, specifications and tailoring the brief to suit particular interests or to satisfy a market need. By year 13, students should negotiate a brief, develop detailed specifications (in regular consultation with the teacher), and carry out all the stages of the design and communication process.

The varied activities involved in graphics practice and the associated visual communication and presentation requirements provide many opportunities for students to gain practical experience.
In planning a graphics programme, teachers should ensure that activities using ICTs are fully integrated into the programme rather than treated as optional extras.

Topics should not be limited to computer-aided design (CAD) and drafting; it is essential that students at all levels be exposed to a broad range of applications and tasks using ICTs. It is also very important to select programs and applications compatible with the educational objectives of graphics.

Students will also use ICTs to communicate and to research information – for example, by using email and faxes, preparing Powerpoint® presentations, web pages and browsing the Internet.

At senior levels, students should be encouraged to explore different programs and to produce work examples that illustrate competency and an appreciation of a particular program's capabilities. Any learning programme at this level should contain a section on computer-generated design work. Senior students should also become familiar with the application and use of such associated technologies as printers, digital cameras, and scanners.

Provision should also be made for senior students to visit design and drafting offices where they can see at first hand the capabilities and vocational applications of ICTs. In some cases, short courses provided by a polytechnic or similar institution may be appropriate.

Ideally, students should be able to access relevant ICTs for graphics purposes, both within the school's graphics room or technology areas and throughout the school's computer network.

Additional Materials

This folder contains the following addtional sections:

- Principles of Design: Definitions
- Mock-ups and Models
- Computer Models
- Drawing

Principles of Design: Definitions

The two main design principles:

Aesthetics

Aesthetics is concerned with the qualities of appearance, visual appeal, good taste, and beauty – the rules that determine how beautiful or pleasing to the eye something is. Elements within this principle include shape, form, colour, texture, finish, environment, point, line, plane, proportion, contrast, pattern, movement, balance, harmony, style, and rhythm.

Function

Function covers how a product, system, or environment works or performs for its intended user and how something carries out its purpose. Key factors include: strength, durability, efficiency, safety, stability, reliabilty, ergonomic fit, construction (and its cost), optimisation, user-friendliness, and fitness for purpose.

Aesthetics: associated elements

Movement

An object with strong "visual movement" tends to be shaped in a way that draws the eye in a certain direction. Its shape or shapes may be asymmetrical, flowing, or dynamic. Objects with less visual movement tend to have more static and symmetrical shapes.

Pattern and rhythm

A pattern is a repeated design element. Patterns are found on many plants and animals (for example, leaves and tabby cats) as well as on manufactured products, such as fabrics and wall and floor coverings.

Rhythm is related to pattern in that it uses repeating elements, but they may have a stronger quality of movement and be in the form of sequences or series.

Proportion

Proportion has to do with the relationship between different parts of an object or composition (or between those parts and the object as a whole). The proportions of an object made to be used, such as a teapot or a jug, may have a functional as well as an aesthetic purpose.

Many shapes in nature have the proportions of the **golden section**, a ratio identified by the Greeks and used in their buildings. Throughout history, harmonious proportion in architecture, painting, and sculpture has often been arrived at using the golden section, which works on the principle that an object's proportions are most pleasing when they are based on the ratio of 1 to 1.618.

Balance

There are three main kinds of visual balance:

- **radial**, where the design elements radiate out from a centre, as in the petals of a daisy or the face of a clock;
- **formal (or symmetrical)**, where the design on one side of a centre line is identical to the other side, as in the front view of an animal or a chair;
- **informal (or asymmetrical)**, where the elements of a design are distributed unequally, as in the side view of a teapot.

Harmony and contrast

A harmonious design is one in which its different elements are in unity with each other for example, its colours may blend together well. A harmonious design might be considered appropriate for the furnishings of a relaxing environment, such as a bedroom.

Contrast, the opposite quality to harmony, involves the use of opposing elements, such as clashing colours and shapes, in the same design. Contrast in a design may be more appropriate for a stimulating environment or when impact is wanted, such as in many advertising layouts.

Style

Style is most often related to aesthetics rather than function. Style is ever-changing. What may be considered ugly or gauche one year may be the height of fashion the next. Whereas it's possible to make objective judgments on the success of a functional design, judgments on style are much more subjective and reliant on individuals' personal responses.

Function: associated elements

Strength and durability

The strength of an object or product is determined by its ability to withstand pressures or forces. Such forces can derive from nature (for example, from strong winds or earthquakes); from users (for example, a builder using a hammer or a woman wearing stilettos); or from within the object or system itself (for example, inside the cylinders of a combustion engine). The development of materials such as fibreglass and carbon fibre has allowed designers to make lightweight, streamlined products that are still extremely strong.

Durability is the ability of a product or material to last in a given environment and to stand up to wear. Durability is a relative concept; our expectations of a product's durability depend on a variety of social, economic, and legal factors, such as how and where it is used, how much we pay for it, and the kind of guarantee it comes with. For some objects or materials, their durability will depend on their strength; for others, flexibility or fitness for purpose will be the key factor.

Safety and stability

Products, systems, and environments must be designed so that they are as safe as is practically possible to use. In many instances, designs have been adapted to make them safer for particular users (for example, rounded scissors for young children) or to prevent certain people from using them (for example, modern medicine bottles with safety caps).

Stability is a factor that is often considered when reviewing the safety and reliability of an environment, system, or design. Anything that is not stable is unlikely to be able to function effectively in the long term, be it a building, an ICT system, an engine, a plant nursery environment, or a food product.

Efficiency

Technically, efficiency is the ratio of useful work achieved to the amount of energy expended. But the term is more often used in relation to a situation where work is productive, with minimum wasted effort or expense.

Reliability

Reliability is the likelihood that a product or system will continue to do its job. The design of a product and the components used in it influence its reliability. Reliability is a much more critical consideration for some products than for others, particularly when safety is at stake. For example, it is much more important that there are no breakdowns in an aeroplane engine than in a lawnmower motor.

Fitness for purpose

Fitness for purpose describes how well a product works in the situation it was designed for and how well it meets the needs of its intended end-users. In order to ensure that a product is fit for its purpose, its designer has to find the right balance between technical factors and the needs of those who will be using the product. For example, a simple “no frills” video player may better meet the needs of many users who would be overwhelmed by a sophisticated player with many additional features.

Fitness for purpose depends on accurate design specifications. If the specifications aren’t right, then even if the product meets them completely, it still won’t be fit for its purpose. Given accurate specifications, the designer then has to make appropriate choices in materials, assembly methods, and so on in order to ensure that the final product meets or surpasses the specifications. In developing solutions, designers need to continually evaluate their design decisions against their brief and specifications.

User-friendliness

The user-friendliness of a product, environment, or system is the degree to which it is easy to use. The relative importance of user-friendliness in the design of a product, environment, or system depends on how widely it will be used. For example, if a product is intended for brief use by a wide variety of people, then user-friendliness will be a more critical consideration than if it is to be used for long periods by a small number of specialists.

Ergonomic fit

Ergonomics is the study of the relationship between people and their working environment, especially in connection with the things they use. To achieve the best possible ergonomic fit, designers have to ensure that equipment and work environments match the capacities and limitations of their users. For example, the height of a table or the size and shape of a toothbrush are decided using ergonomic principles.

Ergonomics relates to the whole working environment, but an important focus is often the size and shape of objects. Designing objects that take account of people's size and shape requires the use of sets of standardised body measurements called anthropometric data, which can vary from country to country. These measurements are incorporated into the design of objects that will be used by many people, such as spectacles, cups, and public seating.

Models

Two and three-dimensional models are used to explore, explain, test, and communicate design ideas. They include mock-ups, which are simple constructions primarily used during development and testing and scaled model representations of the final product. A well-made model is more informative than a drawing because it can be rotated to show such things as the completed object's size, form, surface, texture, colour, finish, and even its weight and balance. Functional models allow designers to test ideas before going to the expense of manufacturing the final product.

Communicative models are widely used in architectural, industrial, and interior design as a means of communicating the form and detail of a conceptual design – for example, to promote a project proposal to a client group. The model is usually carefully made, true to scale, accurate in detail, and highly realistic.

Effective functional and communicative modelling in two or three dimensions calls for a range of skills including a degree of innovation, and an ability to use a variety of materials. Teachers will need to ensure that the basic techniques of modelling are well taught if student modelling results are to be worthwhile.

Model making is an interesting but time-consuming process. When planning programmes, teachers will need to consider the restraints placed on this type of work by the resources that are available (including time, access to equipment and materials).

Group modelling projects can save time and also help to achieve other general objectives. Model making offers exciting opportunities for group projects and role-play activities paralleling real situations in a design office. A number of students can form a project team and each make a significant contribution to the design and construction of a single model.

A model can be viewed from every angle in three-dimensional reality, thus providing a thorough understanding of spatial relationships, shape, and proportion. Photographs of a model or mock-up can be combined with drawings to provide a more comprehensive description of a product or system. Some different types of models are outlined below.

The concept model (a functional model)

The concept or sketch model is used to experiment with a range of ideas and to help decide a product's size, shape, proportions, or colour. Concept models are particularly useful during group discussions of design concepts. They are made quickly from such inexpensive materials as paper, card, or clay.

The static model (may be a functional or communicative model)

The static or block model accurately conveys an object's size, form, colour, and texture. It can be used at different stages of a design process, for example, to evaluate a design, to be photographed for advertisements and brochures, or to communicate a design idea to a client. Static models are also useful in presentations and discussions. They are made to scale in such materials as medium density fibreboard (MDF), plaster, or card.

The working model (a functional model)

The purpose of a working model is to test the function of all or part of a design or to decide how working parts will fit together. It is useful to test how a mechanism will work. The main difference between a working model and a prototype is that a working model may be to scale, and only model one aspect of the overall design of an intended product whereas a prototype is full-size, full representation of an intended product.

The prototype

Prototypes are full-scale models, virtually indistinguishable from the design outcome. They are fully operational, and they differ from the design outcomes only in their method of manufacture or production; they are "one-offs" made by hand before the decision is made to manufacture the product.

Computer Modelling *(may be a functional or communicative model)*

Increasingly, computers are being used to display, explain, and test intended solutions for product, system, and environmental designs. Computer modelling is used extensively in many professions and industries, for example, in planning and reviewing surgical procedures or in representing human, animal, or alien movement in film production in architectural design as tools to communicate and test design ideas with intended users.

Computer modelling has the following advantages over conventional modelling methods. Computer models:

- are often more accurate;
- can be modified easily;

- convert readily to and from working drawings;
- can show internal components;
- are often cheaper to produce than other model types;
- are easily rotated;
- can simulate a variety of materials;
- can be used to calculate the required strength and shape of components;
- can output to peripheral equipment that creates actual components (for example, in sailmaking and product design)
- can incorporate reality in virtual imaging (for example, by capturing human movement and integrating it into a model);
- are produced without the physical tools and materials needed to make 3-D models;
- operate in a virtual environment, so they can be viewed and worked on from a variety of locations;
- are easily transported and displayed.

Because computer models are displayed on a screen, they cannot be viewed or handled in true 3-D. This is a disadvantage if a designer, developer, or client wishes to see exactly what something will look like in reality or to test how suitable a design is ergonomically.

Drawing

Freehand sketching and drawing

Freehand sketching and drawing is emphasised in graphics and technology programmes because these skills are an essential tool in graphic communication and visual thinking and in some forms of functional modelling. In its many forms and uses (for conceptual ideas through to presentation), freehand drawing provides the freedom to create, alter, and perfect shape and form. An ability to conceptualise and modify design ideas through freehand drawing plays an important role in graphics practice.

Instrumental drawing

Instrumental drawing is used for the graphic communication of precise and accurate information relevant to the design, manufacture, and marketing of a product or system. Instrumental drawings are often created on the computer, using precision drag methods and/or using traditional drawing boards and equipment. Students need to develop a knowledge of universal drawing systems and standards and an ability to select and use appropriate instrumental methods (including on computer) in order to communicate effectively. Instrumental drawing is particularly important in communicative modelling.

Colour rendering and illustration

Colour rendering and illustration enhance an object's aesthetic qualities without losing sight of the essential shape description. These techniques give form and plasticity to the shape, transforming a line drawing. With encouragement and guidance in the effective use of a variety of media and processes, students at all levels can thoroughly enjoy and gain advantage from these illustration techniques. These techniques are important in both functional and communicative modelling.