Preliminary & HSC

Work Booklet

Industrial Technology – Multimedia

James Sheahan Catholic High School
Industrial Technology

Much of Australia’s economic, social and cultural development can be related to the capacity of our industries to develop and use technology in the manufacture of goods and services. The effective and responsible application of industrial technologies has a direct bearing upon the quality of our lives. For this reason, the study of industrial technology and its role in industry is relevant and purposeful.

Industrial Technology has been developed to incorporate content related to current and developing technologies. It offers students the opportunity to study the interrelationships of technologies, equipment and materials used by industry and to develop skills through the processes of design, planning and production.

Rapid technological change, particularly in the computer-based technologies, is influencing the nature of our industrial enterprises and the work that is undertaken in these enterprises. As a result, our industrial enterprises are becoming more globally competitive.

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**What is Multimedia?**

When most of us think of a multimedia product we envisage a rich experience full of sound, movement and interactivity. But, by definition, multimedia is any product that employs more than one media element. A newspaper contains text and images. Is it multimedia? In our context we will define multimedia as any computer based product that integrates visual and audio components.

Multimedia products are differentiated from each other by their ability to incorporate different media elements and their degree of interactivity. Interactivity is the ability of a product to respond to a user event, such as a mouse click, and navigate to a multimedia element. The process of integrating media elements and creating an interactive multimedia product is known as software authoring.

The degrees of interactivity a product can have are:

1. **Non-interactive;** the user has no control over the delivery of multimedia elements
2. **Sequential;** the user has control to move backwards and forwards through a sequence of multimedia elements
3. **Hypermedia;** the user has a low degree of interactivity, moving to media elements out of sequence.
4. **Dynamic;** the user has a large selection of controls, to explore and interact with screen elements. The user moves to scenes dependent on a range of responses

<table>
<thead>
<tr>
<th>Product</th>
<th>Type</th>
<th>Examples</th>
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| TV              | Non-interactive, you have to watch a TV program from beginning to end | • features  
• documentary  
• short films and/or videos  
• animations  
• commercials  
• music videos  
• television production of any type (music, drama, comedy, variety, sport) |
| Video tape      | Sequential, you can rewind and fast forward tapes   | As above                                                                  |
| Slide show presentations | Sequential, you can move forward, backwards or to a particular slide in a sequence | Conference presentations  
Product promotions |
<p>| On-line web pages | Hypermedia, links in web pages take you to other pages located on the internet or an intranet. | Web sites |
| Off-line web pages | Hypermedia, links in web pages take you to other pages stored locally on your computer. | Magazine cover disks: CD-ROMs containing articles, and free or demonstration programs |</p>
<table>
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<tr>
<th>Public kiosks</th>
<th>Hypermedia, connects a series of screens providing information to the user</th>
<th>Products located on specialised units in airports, train stations, libraries, museums or art galleries</th>
</tr>
</thead>
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<tr>
<td>Multi-track CD/DVD</td>
<td>Hypermedia, a CD/DVD storing computer data with digital, audio and video tracks</td>
<td>Electronic press kits containing music with interviews, and biographies of artists</td>
</tr>
<tr>
<td>On-line databases</td>
<td>Dynamic, a web based product with a front end allowing you to search, sort, select and view multimedia elements stored on the internet. The content is generated in response to your preferences</td>
<td>On-line shopping, where you can select a range of products to browse and purchase</td>
</tr>
<tr>
<td>Off-line databases</td>
<td>Dynamic, a web based product with a front end allowing you to search, sort, select and view multimedia elements stored on your local computer</td>
<td>Reference material on CD-ROMs such as product catalogues, encyclopaedias and resource lists</td>
</tr>
<tr>
<td>Training products</td>
<td>Dynamic, content is generated in response to your performance in a series of learning activities.</td>
<td>Interactive multimedia learning environments</td>
</tr>
<tr>
<td>Computer and video games</td>
<td>Dynamic, you investigate various scenarios and use controls to explore strategies to win the game. As you move through the game you are presented with new scenarios, dependent on the strategies you employ</td>
<td>Products that allow you to challenge the computer or a friend to solve problems that move you through levels of skill</td>
</tr>
<tr>
<td>Virtual reality</td>
<td>Dynamic, where you are immersed into a virtual world where you can investigate unknown scenarios</td>
<td>Simulations used in crime scene investigation, architectural and engineer design, and training where real experience is too expensive, such as learning to fly a space shuttle</td>
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Section A - Industry Study

Structural factors
- Organisation and Management
- Marketing and Sales
- Production and Efficiency
- Technology and Restructuring
- Quality Control

Technical factors
- mechanisation
- specialisation
- mass production
- automation
- emerging technologies

Environmental and sociological factors
- resources, alternatives, limitations
- recycling
- pollution
- government legislation
- Environmental Impact Studies (EIS)
- sustainable development

Personnel issues
- industrial relations
- entry level training requirements
- retraining and multiskilling
- unions
- roles of industry personnel
- equity/EEO

Occupational health and safety
- government legislation
- industry requirements (standards)
- first aid
- safety training and human factors
- materials handling & workplace safety
- workplace culture
- workplace communication
Structural factors

Business Organisation & Management

Business affects the life of everybody on a daily basis. Business takes inputs and combines them in the process of the production of goods or services. Through this process the business adds value to the inputs, transforming them into an output of goods or services.

People buy these goods or services to satisfy their wants and needs. By selling these, businesses strive to make a profit. The management of the business is responsible for finding the most efficient way of producing goods or services.

To a large extent the type of business structure depends on the good being produced. A relatively small business may produce mufflers. A large business structure is required to manufacture a car.

Businesses can be government or privately owned. The majority of businesses in Australia are privately owned.

Private businesses
The main types of private businesses are as follows:
- sole traders
- partnerships
- companies.

Sole trader
Sole traders own and manage their own business. They have a simple organisation with low costs. The owners of the business have unlimited liability which means that if the business is unable to pay debts, the owner is liable to the extent that they can become bankrupt. Anyone can start up a sole trader enterprise, but some need to be licensed to trade, such as plumbers, builders and electricians.

Sole traders take all the risks and make all the decisions. They have limited capital for expansion and finance is difficult to obtain due to the small and often risky nature of the business. Management expertise is usually limited to the abilities of the owner, although they can use outside consultants or specialists.
Partnerships
Partnerships are a group of people who form a collective business organization to operate the business in common. The usual size of a partnership is from 2 to 20 people. Many firms are husband and wife or father and son partnerships. A partnership is an effective way to reduce tax as each partner is taxed separately. Each partner is equally liable & responsible for the running of the partnership & for the debts.

There are a number of advantages of partnerships:

- **Expense.** Partnerships are the cheapest form of collective business organization to establish.
- **Capital.** It is easier to borrow funds for a partnership rather than a sole trader due to a larger capital base.
- **Simplicity.** Businesses are easy to establish, with or without a partnership agreement.
- **Workload.** Here are more people to share load of management.
- **Taxation.** Business partners are taxed as individuals.
- **Reduced liabilities.** Losses incurred by the business can be used to offset liability on income earned from outside the business.

Companies
A company is a special type of business organisation that allows potentially thousands of people to become owners of the enterprise.

When a company is formed, it is said to be incorporated. Companies are established under the *Corporation Act* (July 1998). This Act is controlled by the Australian Securities and Investments Commission (ASIC). All companies must have a constitution, which is a set of rules that are lodged with ASIC, providing information about all aspects of the company, such as the rights of each shareholder. The rules are critical to the effective running of the company.

With limited liability companies’ the liability of the shareholders to pay for the company’s debts is limited by their investment in the company.

Each company has a top management team called a board of directors. Each director generally is in charge of a separate department within the company. The directors make the decisions that run the company.

A company can be public or private. A public company is open for anyone to buy its shares. A private company restricts ownership, number of shares and transfer of shares.

Advantages of companies are:

- limited liability
- more capital available for large undertakings
- strict legal requirements to safeguard shareholders interests
- funds are attracted from people wanting capital gain
- company can afford to employ specialists
- franked dividends provide some shareholders with a tax credit.

Disadvantages of companies are:

- division between ownership and management
- shareholders rarely participate in decision making.
Structure of industry

1. Hierarchical organisation structure based on division of labour

Senior management is concerned with broad strategic planning.

Middle management is concerned with forming and implementing tactical and operational plans with quantifiable objectives.

Frontline managers are supervisors who implement operational and tactical plans.

Employee communication with senior management often not practical or even possible. Performance is judged against budgets, benchmarks and peers.

A hierarchical organisation is the traditional form of organising an industry. Within a hierarchical structure there is a clearly defined chain of command. The structure of the industry is likened to a pyramid, where most power is at the top of the pyramid and the least power at the bottom. This structure is illustrated in figure 1. Traditionally there are three levels of management in a large industry, but smaller industries are likely to have only two or even one. In a very small industry the owner-manager may be the only decision maker.

**Figure 1.** Hierarchical structure
2. Flat organisation structure and teams

The organisation structure favoured by most industries today is basically still a pyramid, but with fewer levels of management. A flatter management structure is preferred where some of the middle management has been eliminated to allow streamlined communications between workers and top management. The flatter structure allows the formation of informal work groups or teams. This allows the employees to become multiskilled and have a greater say in the operation of the industry. Figure 2 illustrates a flatter organisational structure.

![Flat organisational structure diagram]

**Figure 2.** Flat organisation structure

Each of the four departments shown in figure 2 has a manager who is responsible to the CEO. Each department manager is responsible for the contribution to the strategic plan that their department makes. They are also responsible for the progress of the work teams. In this model the lowest level of management, the supervisors, has been eliminated, with supervisors and workers being merged together at the one level. These workers operate in teams, where they have greater responsibility but also greater accountability.
Marketing & Sales

Marketing is more than just selling and advertising. It's about what you need to do to capture and keep your customers over time. Your marketing plan needs to answer the question:

Why am I in business?
What do customers want?
Why will customers buy from me and not my competitors?

Developing your marketing plan covers four main aspects:

- Market research.
- Marketing goals.
- Marketing strategies.
- Monitor and control.

Marketing Do's and Don'ts

Do:

- Regularly review your marketing strategies to meet changing situations.
- Focus on your customers' wants and needs, not on what you think you have to offer.
- Find a niche - small businesses tend to succeed by offering something that's a bit different.

Don't:

- Waste money on promotional opportunities that don't fit with your strategies.
- Neglect building networks to help you promote your business and build your reputation.
- Forget to assess the effectiveness of your strategies.

Undertaking Market Research
Before you develop your marketing goals and strategies you need to identify what are the most promising market opportunities you should pursue. You need to consider:

Your Products/Services
It may seem obvious, but you will benefit from analysing your product/service offering from the customer point of view. Ask yourself what:

- benefits are you offering your customers;
- are all the features of your products/services and which ones will be most valued by customers;
- will be its likely life cycle and what is the risk of substitutions?
Your Marketplace
Understand your market and identify factors that will impact on your business. Aspects to consider:

- What is its size and is it growing or shrinking?
- Where is your main market located?
- What are its characteristics, eg gender, aspirations, ability to pay?
- What changing social trends and attitudes could affect your business?
- What technological developments are occurring? Emergence of substitute products/services?

Your Customers
Once you have researched your market you can define the specific segments you intend to target. Market segments are groups of customers who share similar attributes and attitudes - which segment(s) you target will depend on the nature of your business and your strengths and capabilities. Segments can be defined by: location, gender, industry, ethnic identity, attitudes (eg adventure seekers) and attributes (eg luxury car owners).

You need to understand the factors that will drive your customers to buy your products or services.

Your Competitors
Identify both direct competitors (those selling the same products and services to the same markets) and indirect competitors (those offering substitute or similar products/services). Information you need to know about competitors includes:

- what exactly they offer their customers;
- how well established they are and their reputation;
- their strengths and weaknesses and what makes them successful;
- their pricing.

Market Research Sources
At this stage your main sources of information will be through:

- discussion with knowledgeable peers and potential customers and suppliers;
- desk research, including web searches, trade/industry material and market statistics, eg ABS, market research reports;
- discussion with business advisers, eg Business Advisory Service.
Your SWOT Analysis

Using the information you have collected you can undertake a SWOT analysis to help you determine your marketing goals. Your SWOT involves assessing:

<table>
<thead>
<tr>
<th>Internally</th>
<th>Externally</th>
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<tr>
<td>Strengths you should build on</td>
<td>Opportunities you should exploit</td>
</tr>
<tr>
<td>Weaknesses you need to overcome</td>
<td>Threats you need to manage</td>
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Put dot points under each heading that honestly reflect your research. You need to develop strategies to deal with each identified issue.

Setting Your Marketing Goals

Your marketing goals build on your broader business objectives and specify:

- what product/service you will offer for which market segments;
- what key benefits you will offer;
- how you will gain a competitive advantage;
- what specific targets you aim to meet over what time frame, eg market share, revenue, customer numbers.

Your marketing goals should pass the SMART test:

- S - Specific
- M - Measurable
- A - Achievable
- R - Realistic
- T - Time bound

Your Marketing Strategies

To put your goals into action you need to develop specific strategies to achieve them. Key aspects that need to be covered:

**Product.** Your product/service offering, including quality, features, packaging, guarantees, after-sales service.

**Price.** Your pricing policy, including discounts, allowances and credit policies. Your pricing should be based on a realistic assessment of all your costs and take into account what the market will bear and the image you are trying to create.

**Promotion.** Your approach will depend on the nature of your business and can include advertising, personal selling, public relations, networking, web-based marketing.

**Place.** How you will distribute your products or services. Consider locations, retailers, inventory implications, transport and warehousing.
Monitor and Control
Marketing is a necessary cost to the business and you should set a marketing budget, including monthly cash flow, as part of your business plan.

Measuring the results of your marketing activities will ensure you continue to get value for your marketing investment. For example, assessing an increase in revenue or customer numbers as a result of promotional activities allows you to decide what activities give you the best return.
Production & Efficiency

**Production** is the act of an article being produced by industry; it can be a measure of efficiency.

**Efficiency** is the effective operation of an industry as measured by a comparison between production and cost.

Efficiency can be measured in terms of a number of different criteria. For example, time, materials use and cost.

*Production is a measure of efficiency.*

*Efficiency can be measured by production.*

The main aim of any industry is to produce an item (or service) to sell at a profit. However, a well organised business will wish to make this profit making an ongoing process. Whilst a one-off sale will usually return a short-term profit, continuous and sustained income from profits is much more desirable.

In order to continue in business, any industry or company needs to make a continuous profit. This profit provides income that enables growth and development within the industry. It may be used to keep shareholders happy by paying them a dividend. It may be used to repair machinery, buy new equipment or to maintain current stock, or it may be directed to the owner's pay packet to buy a new swimming pool, house or car.

It is important to return a *profit*.

In order to return a profit, an industry needs to become **efficient** in whatever it does. In becoming efficient, it will also produce more goods, which can be sold for a profit. This profit can then be re-invested in the company to help it become more efficient, and so on.
Production is inevitably linked to efficiency. The more efficient an industry is the more it can produce. Then it can make a large profit that reflects the company's efficiency. This increased production can, in turn, lead to a company or industry re-investing into its own operations. It may buy more equipment. It may modernise the current equipment. It will need to do this in order to maintain its competitiveness against other similar companies. If too much of the profit is taken away from the business, then the efficiency of that company as measured against other similar companies is in decline.

Efficiency is dependent upon the company's resources and its ability to manage these in respect to such areas as:

- it's location (or address)
- access to surrounding industrial or technological facilities
- the capabilities of the resources, technology and equipment on site
- skilled and semiskilled workers' expertise and training
- management expertise and training
- access to finance, loans or capital
- access to modern assembly techniques and similar technologies
- access to labour saving devices
- a flexible and willing workforce.
The following strategies are just a few examples of current industry management solutions to efficiency problems. Some of these are covered in other units of work for the Industrial Technology course. Solutions to efficiency problems include:

- mass production
- robotics
- power tools, e.g. electric, battery, pneumatic (air powered), hydraulic
- conveyor belts
- standardisation
- lean production
- outsourcing
- computer-assisted equipment, e.g. computer-aided design (CAD), computer-aided manufacturing (CAM)
- quality control and "quality circles"
- multiskilling
- specialisation
- electronic ordering and fund transfers
- invoiceless purchasing.

<table>
<thead>
<tr>
<th>Industry needs to be efficient by:</th>
<th>Disadvantages and adverse effects:</th>
</tr>
</thead>
</table>
| increasing productivity | • mass produced pieces lack originality and individuality  
| | • there is less need for qualified tradespeople  
| | • there is more waste and more need for recycling |
| reducing total production costs for each product | • there is a mind-set of a planned obsolescence of products  
| | • products are often not economically repairable if damaged or faulty |
| introducing automation, computerisation or robotics, aimed at reducing labour costs | • a higher skill level is needed to maintain a job  
| | • multiskilling is often required  
| | • career changes may be needed in order to maintain a quality of life  
| | • automation reduces a need for unskilled labour |
| promoting a cashless exchange for goods | • there may be increased debt due to ease of purchasing  
| | • there are difficulties in repaying this debt |
| standardisation of parts and technologies | • industrial monopolies of parts and technology become more difficult to control |
| keeping minimum stock on hand and thus saving on storage costs | • a lack of and availability of stock  
| | • can cause extended waiting times for spare parts |
| promoting the necessity of specialisation in production | • technology is often out of pace with society’s values  
| | • specialisation itself is easily made obsolete by emerging technologies |
| maintaining a competitive edge against other companies | • there is often a rapid technological change affecting all levels of society  
| | • there is a lack of communication and effective links to education and training institutions  
| | • there is a general “greed is good” and “money can solve everything” philosophy which is detrimental to society |
Technology & Restructuring

As the business environment changes, so must individual organisations. Businesses and organisations need to constantly examine their business practices and structures to ensure they continually improve if they are to survive in a rapidly changing world.

Managers are responsible for the structural changes that take place within any business organisation. Structural change, commonly called restructuring, refers to changes made in how the business is organised. Any restructure must be based on the analysis of accurate data such as production statistics and financial records and fully researched prior to commencement.

The need for restructuring

Businesses need to restructure for many reasons. Over recent years the need for changes in business structures has included:

- the emergence of new technologies
- the emergence of new materials
- the introduction of new production techniques and processes
- the development of new products and services
- the necessity to reduce costs and improve profits
- the need to attract investment
- ensuring the business operations run smoothly
- streamlining operations
- empowering employees to make their own decisions
- developing a teams approach
- changes in workplace culture
- the need for improved environmental protection
- Occupational Health & Safety legislation
- The need to reduce waste in time and materials
- Environmental considerations

Managing the restructure

Research and careful management of the change process are essential for success in any restructure. Managers need to have a clear understanding of what they wish to achieve and how they are going to achieve it prior to them starting any restructure. This vision should be shared with all stakeholders to gain a sense of common purpose and understanding.

The most successful restructuring process will occur when those involved in the restructure are involved in developing the new structure and given ownership of as much of the process as possible.

The specific processes used by managers in any restructure will vary depending upon the aim and extent of the restructure. They may implement processes such as the principles of Total Quality Management, the Australian Quality Council’s PDSA 9 Step Improvement Process or “Paradigm Zero” change.
Quality Control

“The process of making sure that products or services are made to consistently high standards.”

Quality Control traditionally refers to the process of checking every manufactured part and ensuring it conforms to Customer requirements. When manufacturing hundred if not millions of parts Quality Control is not feasible.

Quality Assurance is a process of measuring a defined sample of parts at a regular frequency during the manufacturing process and using Statistical Tools to be assured that the Overall Quality of the parts being shipped to customers meets their requirements. The use of these Statistical tools leads to this process also being referred to as Statistical Process Control (SPC).
Mechanisation & Specialisation

Mechanisation
Mechanisation refers to the process of making something (a task) mechanical. It also refers to the process of developing machinery to perform tasks that were once manual. This also assists with mass production of products and improves product efficiency.

There are many advantages and disadvantages that mechanisation brings to an industry. Some of these advantages include-
- More products can be created faster
- Have settings so that the product is not slightly altered and remains accurate - no human error
- There is only a small amount of setting up that needs to be done
- Can do work in areas where workers risk injury - eg lift heavy equipment, work with chemicals
- Retraining opportunities, including multiskilling

Some disadvantages include-
- Initial cost of machinery is expensive
  Can also take up time when repairing which takes up production time
- Machine operators can get RSI (repetitive strain injury)
- Employees can lose their jobs, ie – redundancy, retrenchment
- Overtime pay is lost
Specialisation

Specialisation is when the production process is split up into different tasks and each worker performs one of these tasks.

The productivity gains of the division of labor are important within any type of production process, ranging frompin manufacture to software production to legal practice and medical care.

The division of labor makes trade necessary and is the source of economic interdependence.

**ADVANTAGES OF SPECIALISATION**

To the business:

- Specialist workers become quicker at producing goods
- Production becomes cheaper per good because of this
- Production levels are increased
- Each worker can concentrate on what they are good at and build up their expertise

To the worker:

- Higher pay for specialised work
- Improved skills at that job.

**DISADVANTAGES OF SPECIALISATION**

To the business:

- Greater cost of training workers
- Quality may suffer if workers become bored by the lack of variety in their jobs

To the worker:

- Boredom as they do the same job
- Their quality and skills may suffer
- May eventually be replaced by machinery
Mass production & automation

Mass production

Mass production is the large-scale production of goods in factories. Originally, very small numbers of products were made by craftsmen in home workshops. But, the increasing demand for consumer goods following the industrial revolution meant that larger numbers of products needed to be manufactured in a more efficient way.

To facilitate the mass production process, organisation of the following factors is necessary.

1. A division of labour, where the manufacturing process is broken down into small specialised tasks that each worker carries out over and over again.
2. The standardisation of parts across a number of products so that large numbers can be made cheaply and efficiently.
3. The development of machinery to perform standardised tasks and produce components.
4. The production process needs to be designed to efficiently integrate the machine processes and human tasks.

Some of the advantages include:

- efficiency of production: less time is taken to produce goods
- ‘economies of scale’: cheaper to make products in large quantities
- workers only need to be trained in one or two tasks.

Disadvantages include:

- boredom for the workers
- occupational overuse syndrome (repetitive strain injury)
- low job satisfaction for workers
- large stock piles of finished goods waiting to be sold
- difficult to change the product’s design quickly to respond to changing styles and consumer demand.

These disadvantages have led to a change in direction for manufacturers to try and be more responsive to changes in the marketplace.

The development of ‘just in time’ (JIT) manufacturing has evolved as an appropriate production technique to address the problems of excess stock and lack of responsiveness by manufacturers, to trends in the marketplace.
Automation

Automation is the process in industry where various production operations are converted from a manual process, to an automated or mechanised process. Let's assume that a person is operating a metal lathe. The person collects the stock, already cut to size, from a bin. He, or she, places it in the lathe chuck, and moves the various hand-wheels on the machine to create a component; a bolt could be such an item. Once finished the person commences the process again to make another item. This would be a manual process. If this process were automated, a person would place long lengths of bar into the feed mechanism of an automatic lathe. The lathe mechanisms feed the material into the chuck, turn the piece to the correct shape and size, and cut it off the bar before commencing another item. This is an example of an automated machine in a manufacturing process.

It is also possible to automate assembly processes. In this case, several steps in the assembly of the components of an item are carried out automatically. For example, the components of a food container: top, bottom and body, may be formed and assembled into a finished container through the use of mechanised machine processes, instead of being done manually.

Modern automated processes are mostly controlled by computer programs which, through the action of sensors and actuators, monitor progress and control the sequences of events until the process is complete. Decisions made by the computer ensure that the process is completed accurately and quickly.

Through automation, workers are freed from unpleasant, hazardous, repetitive and tedious work. However, automation means that fewer people are required to complete the same amount of work. Also, higher skill levels are required to setup and operate automated machines and this results in the displacement from the workplace of semiskilled and unskilled workers. Displaced workers need to be retrained if they are to retain a place in the workforce. Training in computing, electronics and maintenance systems is now required to replace training in machine skills.

Most Australian industries are now highly automated. This has resulted in many thousands of workers being made redundant or retrained to enter new industries. Examples of industries that have applied automation include the iron and steel industry, manufacturing industries, the automobile industry, service industries, banks and communications.
Emerging Technologies

Emerging means to rise from or come into existence, technology refers to the application of science to commerce or industry with an objective. Therefore an emerging technology is something that has been scientifically created for a purpose in the commercial environment and society. Multimedia is the largest growth area for emerging technology. For small businesses this means that they can have access to high quality products at a lower, more affordable cost. With this technology they are also able to be competitive in the multimedia industry and can produce a more professional end-product.

There are many types of emerging technologies, many of which have served a purpose in the multimedia industry. Emerging technologies can mean a new product or advancements on already existing products. Whether it be making something faster and more efficient, making something more compact and portable (e.g. Blue Booth digital cordless headphones), a new design or look, adding more functions (e.g. printing from your mobile) and capabilities or even creating something entirely new that can be used to benefit a business or a person in some way. For many of the technologies emerging today other, older, less advanced technologies get replaced.

Although technological advances play a major role in multimedia industries, they also play an important role for many people living in Australia. Australia has the highest mobile phone usage rate and the second highest internet connection rate globally. This means that Australians rely heavily on the availability of a variety of mobile phone types, whether it is for business or for personal use.

New types of mobile phones such as the 3G have become more and more popular due to the advances in its capabilities. 3G phones allow multimedia data, such as video to be transferred to another person at the push of a button. This allows better communication between workers and employees as it is possible to communicate potential ideas and have meetings with people over a 3G phone. 3G phones are able to transfer high quality multimedia documents at fast speeds (sometimes up to 57.6mb/sec), again making it more efficient for employees to communicate with each other. These phones are also able to be connected to laptops to transfer data. Newer 3G’s can display over 65000 different colours, have dual sound speakers that deliver quality sound, can compress files, digital music player, ability to combine video and text, streaming of video and live events as well as java based games with the ability to download more java games into the phone. So the advances in technology have made it much easier for people to communicate their ideas through the varieties in media.
iii Environmental & Sociological Factors

Resources, alternatives, limitations
Recycling

Fifty years ago our homes had a few electrical items -- a radio, TV, fridge, vacuum, record player, maybe a washing machine. In today’s ‘electronic age’, our homes contain video recorders and cameras, microwaves, clothes dryers, dishwashers, sega games, computers, music centres, telephone answering machines, faxes, power tools, and a range of kitchen appliances. Our workplaces have undergone a similar shift, with IT or ‘information technology’ such as faxes, photocopiers, computers, laser printers, scanners and multimedia devices.

This case study takes a look at the hidden environmental story behind electrical and IT products and investigates the options we have when these products no longer work or have simply become out of date.

WHY ARE WASTE IT AND ELECTRONICS IMPORTANT?

Electronic and IT products are being thrown away in increasing numbers and at increasing rates.

It was predicted that by the year 2005 about 150 million personal computers will be in US landfills -- one football field a mile high.

Whilst they may only represent three percent of our waste, end-of-life electrical and IT products are important for other reasons:

- Products such as fridges and photocopiers are large and don’t degrade in landfill.
- Many contain small amounts of hazardous materials -- the back of television screens and computer monitors are coated with about one kilo of lead.
- Electronics contain tiny amounts of valuable, scarce raw materials. A typical computer circuit board contains copper, iron, aluminium, bromine, lead, tin, nickel, antimony, zinc, silver, gold, cadmium, tantalum, molybdenum, palladium, beryllium, cobalt, cerium, platinum, lanthanum and mercury.

LIFECYCLE IMPACTS

Manufacturing electrical and IT products uses energy and produces waste. Silicon Valley, birthplace of the computer industry, is home to the highest concentration of hazardous waste sites in the US. To get a complete picture of environmental impact we need to look at the product from its cradle to grave, see box below.
DESIGN TO DISCARD

The idea behind 'mass production' is to make many items cheaply. Making products to last longer costs more (especially when disposal is 'free' to producers) and long-term savings aren't obvious when we're in the shop. 'Designing for obsolescence' creates sales opportunities as customers come back when products no longer work.

Another reason for the greater number of electrical goods in our garbage is the increasing pace of technological change. As new models are released more often, 'old' models are superseded and discarded more frequently.

Computers are a classic example. In the 1970s new microchip processors were developed every year or two. These days newer, faster chips come out every three months. The competitive urge to use the latest and fastest chip drives computer manufacturers to bring out new computers every six months. The cycle continues -- as new software is developed to take advantage of faster computers. Old computers can't use new software -- so consumers face the choice of being 'left behind' or buying more often. Do you want to buy a new computer every couple of years?

And before you buy, you might ask yourself whether the 'latest model' on the shelf is just a stylish rehash of the old product.

THE PHONE

A UK company which accepts discarded telephones for reprocessing estimates that more than 80 percent of the phones they receive are in perfect working order.

Extending Producer Responsibility can shift 'end of product life' costs to producers creating incentives to 'extend product life'. Let's have a look at some of the options this might bring consumers.

My computer stares at me 40 hours a week

- COMPOSITION: It's made up of 25 kilograms of plastics, metals, glass and silicon. Its heart is just a hundredth of a kilo of silicon and metal formed into integrated circuits known as 'chips'. Though weighing next to nothing, making chips generates the most waste.

The 400-step process involves silica, carbon, hydrochloric acid, hydrogen, ultra-violet rays, phosphorus, boron, gold, silver and precision machinery. In Malaysia workers get a few dollars an hour cutting silicon chip wafers.

Circuit boards are made from copper, fibreglass, epoxy resin, more chemicals, heavy metals, energy, water and tin solder.

- IMPACT: Making my 25 kilo computer generated 63 kilos of waste and used 27,700 litres of water and 2300-4000 kilowatt hours of energy.

- PREFERRED: Flat panel laptops produce half the waste to make and run on a third of the power.
WHAT ARE THE ALTERNATIVES FOR END OF LIFE?

REUSE

Many 'old' computers are still useful if not 'state of the art'. Redistributing and reusing these computers is increasing in the US, where tax concessions are granted to companies who donate unwanted equipment. But it is wishful thinking to assume that reuse of dated technology will suit everybody and every product. Reuse needs to be complemented with cradle-to-cradle design, repair, reconditioning, upgrading and recycling.

RECYCLE

Electrical and IT goods are built from components made from materials as diverse as glass, metal, plastic, cardboard, textiles and even wood. Estimates suggest that at least 95 percent of a computer or television can be recycled. But of course it's not so easy to disassemble these products for reuse, recycling, or reselling. Local councils don't have the resources to do this, and so we see appliances being dumped in landfill or on the kerbside.

TO RECYCLE A TELEVISION

You need to collect the old TV without breaking it then dismantle into nine components -- to give circuit boards, cables, capacitors, cathode ray tubes, copper wire, aluminium, steel, plastic and wood. Cathode ray tubes can be further split into the metal mask, the front glass (minus the fluorescent coating material), and the tapered back glass.

Collecting, dismantling and recycling a television needs to be planned before the old unit lands on our kerb. Cradle-to-cradle thinking when we design can make product reuse and recycling more viable. Table 1 outlines some tools designers can use.

What do recyclers say? One UK electronics recycler recovers and resells nearly 80 percent of the plastics it handles. It claims plastics can be recovered to 100 percent purity for less than it costs to make virgin resin. What is needed is a 'clean', unmixed waste stream and products made from pure, stronger plastics. This recycler is calling for product takeback legislation.
REMANUFACTURE
Appliances are often thrown away simply because one component no longer works. In these cases remanufacturing might be more eco-efficient than recycling.

Case study 1: Remanufacturing toner cartridges
Toner cartridges are the containers which hold and gently spill powdered toner or ink onto paper as it passes through printers and photocopiers. When your cartridge runs out of toner, you have a couple of options. One is to recycle. This might involve shipping the cartridge overseas, then separating it into four kinds of plastic, aluminium, steel, teflon, glass fibre, and rubber; then melting, remoulding, rebuilding and refilling the cartridge.

The other option is to call a local remanufacturer -- there are 400 in Australia -- who replaces worn parts (such as the light sensitive drum which rolls toner onto the page and the felt wipers which keep the unit clean) and then refills the cartridge. According to remanufacturers, this process can be repeated up to ten times. And it costs significantly less than new or recycled units -- in terms of dollars and energy.

TABLE 1
Cradle-to-cradle design
- DISMANTLING -- snaps replace screws and welding.
- RECYCLING -- fewer materials of greater purity. Component labelling.
- UPGRADING -- modular construction, simpler casings.
- RECONDITIONING -- parts which wear more quickly can be bought separately, and are easily replaced.
- DURABILITY. Parts which quickly wear are designed to last or become redundant. An Australian firm, Kyocera, has designed a printer without a toner cartridge -- toner goes directly into the machine.
- 'FORWARD CAPABILITY'. For example upgradeable computers -- with access for extra ports, additional memory, and newer microprocessors. Other examples include washing machines and dishwashers with upgradeable 'software' which controls cycle times and energy use.
- Eliminate hazardous materials. For example, flame retardants (which contain bromine), mercury-free connectors, cadmium and mercury free batteries.
Pollution

The EPA (Environment Protection Authority) is a statutory government body that is responsible for administering the Protection of the Environment Operations Act 1997 (POEO Act).

The broad purpose of this act is to reduce the levels of all types of pollution:

- air pollution,
- water pollution,
- noise pollution and
- waste management.

Government legislation (Pollution)

- State and local governments planning regulations
- POEO Act
What is an Environmental Impact Statement (EIS)?

The purpose of an EIS is to explore the potential environmental, cultural, social and economic impacts likely to be associated with the project and identify approaches to managing these impacts.

The EIS incorporates comprehensive research and consultation to provide:

- an outline of the proposed project and activities that may have environmental, cultural, social or economic effects;
- details of the existing project environment and surrounding land;
- an assessment of the environmental, cultural, social and economic impacts that may be generated by the project;
- information on the methods for reducing and controlling potentially adverse impacts;
- a summary of the public consultation undertaken as part of the EIS preparation;
- a series of environmental management plans for specific project effects.

An environmental impact study (EIS) is the detailed study of the potential effects of a designated development on the local environment. Environmental impact studies should assess the existing site and conditions and evaluate the anticipated impacts on the flora, fauna, economy, historical and social factors of the new development.

An EIS is important to avoid damage to a local area in terms of its ecology, air and water quality and to ensure long-term sustainable, minimal impact development.
How can the community participate in the EIS?
Community consultation is an integral part of the EIS process for Ind-Tec.

The objectives of community consultation are to:

- encourage stakeholder involvement and participation in the decision-making process to facilitate enhanced outcomes;
- provide information to stakeholders about the intent and impacts of Ind-Tec thereby enabling them to make informed decisions;
- enable a process where project sponsors can receive feedback from stakeholders on issues of interest;
- maintain open and transparent communication on all aspects of the project and the environmental impact assessment work;
- provide a range of opportunities for stakeholders to identify key issues for consideration in the EIS; and
- proactively work with stakeholders to develop recommended strategies that will minimise adverse impacts.

Ind-Tec is keen to hear from community members who have questions or comments. A program of community meetings will be held during the EIS process and stakeholders will also be able to access project information through a range of other mechanisms including:

- Phone
- Website
- Email
- Reply Paid Post
Sustainable development

Satisfying the material needs (food, housing, clothing, infrastructure, energy, etc.) of the world's growing population requires the continual use of the Earth's renewable and non-renewable resources.

Ensuring that these resources are utilised responsibly, now and into the future, requires governments, industries and individuals to manage development in an ecologically sustainable manner.

The most common definition of sustainable development, and the principle used to formulate most government policy is:

"... to meet the needs of the present without compromising the ability of future generations to meet their own needs."

Thus, sustainability necessitates an interrelationship of the social, economic and environmental needs of a developing world.

1. **Deforestation** is the process of clearing forests.
2. An **ecosystem** is a community of plants and animals existing in an environment that supplies them with water, air and other elements they need for life.
3. A **renewable resource** is able to be replaced or replenished, either by the Earth's natural processes or by human action. Air, water and forests are often considered to be example of **renewable resources**.
4. **Resources** are the machines, workers, money, land, raw materials and other things that can be used to produce goods and services and to make a country's economy grow.
Personnel issues

Industrial relations

If you are offered a job When offered a job, you should ask your employer for the following information:

- the duties you will be required to undertake in the job
- your pay rate and employment conditions
- the award your job is covered by, if applicable
- the classification or grading of your job as set out in the relevant award
- if you are employed on a full-time, part-time, temporary or casual basis
- the number of hours you will be required to work each day and week.

Ask for these details in writing, in case you need to refer to them later.

You may be offered a job for a trial or probationary period. If you accept, you must be paid for any work you do. This also applies to any training your employer requires you to do, including the cost of the training course.

Your basic entitlements

Your employer must pay you at least what you are entitled to under the award or enterprise agreement that applies to your job, which is set by the NSW Industrial Relations Commission. If you are employed under a contract your employer must pay you at least the minimum wage and entitlements as set out in the appropriate award.

As a guide, most employees (except casual employees) are entitled to:

- four weeks paid annual holidays each year
- a minimum of five days sick leave each year,
- which can be used when you are too ill to work, and under some awards, when you need to care for sick family members
- parental leave, which is usually unpaid leave available when you become a parent or adopt a child
- two months paid long service leave after 10 years of service (this may apply to some casual workers).

The entitlements you receive will depend on whether you are employed on a full-time, part-time, temporary or casual basis and which award covers your job.

Generally, if you work part-time you should receive all the entitlements of a full-time employee on a pro-rata or proportional basis.

If you are a casual worker you should receive an additional payment, called a loading, instead of sick leave and other entitlements, plus an additional 1/12th of the hourly rate each hour for holiday pay. Check your award.

NSW laws also permit all employees to choose whether or not to join a union.
Getting paid
Most employees are entitled to a legal minimum rate of pay, which is set out in the award or enterprise agreement. This can vary, depending on what type of work you do and the time of day or week you work. Of course, you can be paid more than the amount stated in an award.

Employees may be paid allowances for tools, laundry, car usage, travelling, for doing certain tasks or working outside of their regular hours. Employees may also receive penalty rates for working at nights, on weekends or public holidays. Check your award.

Your employer must pay you regularly and, if you demand, must pay you at least once a fortnight. Your employer is not allowed to deduct any money from your pay, unless you have agreed in writing or it is required under the law. Under no circumstances can deductions be made from your annual holiday pay.

You must be paid in cash, by cheque or have the money deposited into your bank account. Your employer must give you a payslip when you receive your pay which explains what you are being paid.

Your responsibilities
Your award or enterprise agreement explains your general responsibilities. Examples of some of your responsibilities as an employee include:
- obeying any lawful and reasonable instructions given by your employer
- working with your employer to maintain a safe and healthy workplace
- giving the appropriate period of notice when you intend to leave your job.

Ending your employment
Your employment can be terminated by you or your employer by giving the appropriate notice, preferably in writing. Check the relevant award for notice periods.

If you are an apprentice there are special conditions for ending your employment. Contact the Department of Education and Training for further information.

An employer may dismiss you on the following grounds:
- when your employment contract has reached its set termination date
- if there is a downturn in the business or if the business has restructured and your job no longer exists (this is referred to as a redundancy, check your award for any additional payments that may apply)
- for poor or unsatisfactory work performance
- on medical grounds, if you can no longer perform your duties (but not within six months of your workplace injury occurring)
- for gross or wilful misconduct, which can result in being dismissed without notice.

If you think that you have been dismissed unfairly, it is possible to challenge the dismissal in the IRC by lodging a claim for unfair dismissal with the Industrial Registry within 21 days of being dismissed.
**What is an award?**

An award sets out the rights and obligations of employers and employees engaged in particular types of work. There are many different types of awards covering different industries and occupations.

Awards cover conditions of employment including:

- hours of work
- pay rates, penalty rates, overtime and other loadings, such as annual leave loading
- allowances, for example, tools or uniform allowances
- leave entitlements
- employment protection provisions, for example, redundancy payments
- part-time or casual work.

**How are NSW awards made?**

The NSW Industrial Relations Commission makes NSW awards after being approached by an employer organisation or employee organisation (union) to create a new or revised award for a particular industry.

Awards can also be made to settle industrial disputes.

**Who is covered by a NSW award?**

A NSW award covers all employers and employees in the industry or occupation to which it relates, whether or not they were involved in creating the award. Every award has a section that explains the industry or occupation covered by the award.

Award pay rates often increase after each State Wage Case following an application to the Commission by parties to the award. The Commission also updates and reviews awards every three years.

**What about federal awards?**

Some employees who work in NSW are covered by federal awards. Sometimes, both federal and NSW awards apply to the one workplace. But each employee will only be employed under one award that could be a state or a federal award.

A federal award will specify the category of employee it covers. It will also indicate which employers are covered either individually or through their membership of an employer organisation.

Information on federal awards can be obtained by telephoning the federal Department of Employment and Workplace

**What is an enterprise agreement?**

An enterprise agreement, like an award, sets out the rights and obligations of employers and employees engaged in particular types of work in a business.

It may be negotiated between an employer and the employees or with a union on behalf of those employees.
When the enterprise agreement covers the same employment conditions as the award, the enterprise agreement overrides the award.

An enterprise agreement may cover one or more conditions of employment. If any employment conditions are not covered in the enterprise agreement then the award conditions apply. However, an enterprise agreement must comply with all NSW laws regarding employment rights and obligations, such as minimum entitlements to parental, annual and long service leave.

Every enterprise agreement must be in writing and signed by or on behalf of the parties. The parties to the agreement must be named and the agreement must state the employees who will be covered by the agreement.

Generally, all enterprise agreements must be for a fixed term of between one and three years. However, an enterprise agreement continues in force beyond that term until it is cancelled.

**How is an enterprise agreement approved?**

An application to approve an enterprise agreement can be made to the Industrial Registrar of the NSW Industrial Relations Commission. An enterprise agreement is not enforceable unless it has been approved by the Commission.

**When will the Commission approve an enterprise agreement?**

The Commission will approve an enterprise agreement if:

- the agreement complies with all relevant Act requirements
- the agreement does not, on balance, provide a disadvantage to the employees when compared with the award
- the parties understand the effect of the agreement
- the parties are entering into the agreement of their free will
- the agreement does not unfairly exclude some employees.
Resolving industrial complaints
The following three steps outline what you should do if you believe you have not been paid correctly or received your due entitlements.

Step 1: Find out if your job is covered by a NSW award or enterprise agreement
To work out if you have been paid incorrectly or not received your due entitlements you need to know:
- the name of your award or agreement
- your classification under the award or agreement
- your employment status (full time, part time or casual)
- your pay rate under the award or agreement
- the entitlements owing to you under this award or agreement (for example, annual leave, penalty rates, overtime, etc).

Step 2: Write to your employer
If you believe you have not received the correct pay and entitlements, you should write to your employer about the problem. They may have made a genuine mistake that can be easily rectified by discussing the issue with you.

Step 3: Take further action if the issue is not resolved
- contact your union for assistance, if you are a member
- take your own court action through a small claims application
- take your own legal action through a solicitor.

If you are unable to do any of the above, you may lodge a formal industrial complaint with the OIR.

Investigating your industrial complaint
The OIR investigates alleged breaches of NSW industrial relations legislation, awards and enterprise agreements. The OIR may prosecute an employer under these laws. If you lodge a formal industrial complaint about an employer, the OIR may investigate your allegations.

The OIR does not represent you or your employer when investigating an industrial complaint.

When can the OIR investigate your industrial complaint?
Generally, the OIR can investigate your industrial complaint when:
- you meet the OIR’s assessment guidelines
- you have already tried to resolve the matter with your employer
- the underpayments relate to work you have undertaken in the last six months
- your yearly pay did not exceed $94,900 gross.

Important information about OIR investigations
Usually, the OIR will investigate your most recent six months of employment. If no breaches of NSW industrial relations laws are found, the OIR will terminate its investigation of your industrial complaint. If it is considered that your employer has breached a law, the OIR may extend its investigation to an earlier period of your employment.
Entry level training requirements

Certificate IV in Multimedia

This qualification is part of the Film, Television, Radio and Multimedia Training Package. It provides multimedia training for people who want to produce, edit or test multimedia products such as animations, graphics, games, video and sound, CD-ROM's and interfaces. The industry focus of this qualification prepares students for the demands of the workplace by providing relevant experience in multimedia communications, problem solving and interactive design. The qualification equips students with specialised and innovative multimedia skills whilst encouraging professional development through the completion of individual and team based projects. On completion students will have acquired the skills relating to multimedia at entry level for the multimedia (design) industry and may seek employment in the following areas: print media, photography, video and sound, animation and related design, interactive media and web design.

Entry Requirements

Year 10 or equivalent plus one year's full-time study in a relevant area; or year 12 or equivalent; or mature age

Related Occupations

Graphic Designer
Multimedia Developer
Photographer
Programmer (Information Technology)
Web Designer/Developer

Master of Internet Technology

A unique course that provides a systematic treatment of the Internet as a whole. Students gain general and specialist skills in such diverse areas as internet network operation and management, internet access technologies (including wireline technologies, wireless and mobile systems as well as satellite systems), Internet content servers and caching systems, network management, multimedia communications, Internet service provision and web technology as well as Internet enabled electronic commerce.

Entry Requirements

Relevant pass degree (60% GPA); or relevant pass degree plus 2 years' internet/computer related experience

Related Occupations

Systems Designer (Information Technology)
Web Site Administrator
Graduate Diploma of Interactive Multimedia

This course aims to educate the innovators and future leaders of the various professions working in multimedia. Students need high-level skills and experience in their own professional field, along with a broad understanding of the social and economic impact of multimedia technologies.

Entry Requirements
Pass degree or equivalent; or substantial senior experience

Job Destination
Destination for Graduate Certificate/Diploma in Visual and Performing Arts

Related Occupations
Analyst (Information Technology)
Multimedia Developer

Activity: Research the following careers in the Multimedia industry:

- Animator
- Graphic designer
- Graphic Designer
- Illustrator
- Photographer
- Web Designer
- Web developer
Retraining & multiskilling

When a worker is retrenched, her or his employment contract is ended for lawful and legitimate reasons. Retrenchment, or redundancy, applies mostly to permanent (full-time or part-time) workers. Generally, an employer will negotiate with an employee the circumstances surrounding a potential redundancy and offer the employee the offer to be made redundant. Redundancy normally includes a generous 'lump sum' payment and other benefits, like retraining options and help finding alternative employment. Retraining is emerging as a good way to avoid being made redundant. It involves learning new skills or creating new work opportunities for yourself through education, training and networking. Many employers will help you retrain or help you find alternative employment.

Redundancy and retrenchment

Retrenchment is the act of being made redundant, that is, the job is redundant (of no use) and the employee is retrenched because they no longer have a job to do. Redundancy applies when an employer decides that an employee’s job no longer has to be done by anyone. The employee will be retrenched and the position will cease to exist. It is important to note that redundancy has nothing to do with an employee's performance, conduct or abilities. It is also important to note that under the definition of redundancy, the employee's position may not be taken by a new employee, because the position must no longer exist.

Redundancy occurs for a number of reasons. Often, business cycles improve or technology intervenes, making a certain job unnecessary; at other times business experiences a downturn, also making a position dispensable or too costly for a business to survive. Whatever the legitimate reason for redundancy, an employer is required by law to give plenty of written notice to the affected employee, so this person can arrange alternative employment. The law also requires employers to clearly state reasons for making employees redundant.

Many Awards, Enterprise Agreements, individual agreements and contracts provide generous pay and entitlements to redundant employees. In general, apprentices, trainees, casual employees and sub-contractors are not entitled to redundancy pay and entitlements.

Retraining

On occasion, severance pay and redundancy entitlements may not be required when a transmission of business has occurred, such as where a business has changed its operations, such that most employees can continue to be employed in a new capacity after the changes. Retraining is the acquisition of new skills by an employee. These skills may enhance skills that they already have, or they may be different skills that the employee is willing to learn to stay employed. The benefits of retraining staff for a business is that they can keep staff that they know and trust and who are familiar with the business' operations.
Multiskilling

- is where labour organisation is structured so that workers possess a range of skills appropriate for use on a project or within an organisation.

A multiskilled worker is an individual who possesses or acquires a range of skills and knowledge and applies them to work tasks that may fall outside the traditional boundaries of his or her original training. This does not necessarily mean that a worker obtains or possesses high-level skills in multiple technology areas. However, the worker can be an effective and productive contributor to the work output of several traditional training disciplines.

Some of the reasons for the introduction of multiskilling include:

- to increase labour productivity
- cater for the declining number of tradespeople and cater for a critical skill shortage
- create a more flexible labour force able to meet challenges, improve project performance and better utilise the current pool of skilled workers
- to utilise labour so that workers possess a range of skills suitable for more than one work process
- develop competency within the workforce and allow full deployment of qualifications across the industry
- assign workers tasks based on their ability to perform the needed skill and not restricted by traditional job descriptions or work boundaries.

Problems that affect multiskilling are both basic and practical. Basic problems are difficult to overcome and include limits on human skill retention and the difficulty of maintaining a multiskilled workforce from a management and financial viewpoint. Practical impediments include the organisational requirements, production management structure, resistance to change, qualifications requirements and the acceptance of multiskilling in both union and non-union work sites.
Advantages of multiskilling

1. **Flexibility**
   Workers who are able to perform a large number of tasks can fill in for other workers, increasing workforce flexibility.

2. **Communication**
   Knowledge of various tasks can increase the understanding of other tasks and improve coordination.

3. **Positive effects on innovation**
   The processes of improving design concepts are easier because of the individuals ‘multi’ knowledge.

4. **Employment security**
   A multiskilled workforce is not as threatened if skills become obsolete because of new technology.

5. **Project efficiency**
   Through the increased level of multiskilling, work can be reorganised so that it can be performed most efficiently. Multiskilled workers carry projects through, sometimes all the way from start to finish often taking ‘project ownership’.

6. **Competitive market**
   Cost saving are passed onto the customer, through the decrease of labor cost due to reduction of turnaround time and number of workers involved.

7. **Management effectiveness**
   Multiskilling is most valuable in the areas of management. Here it effects the reduction of product completion time (e.g. reduced subsequent production line delays), the decrease of project planning time (e.g. only one employee has to learn the details of the project), and the cutback of administration costs (e.g. faster completion of pay claims and materials billing).
Unions

Trade unions have been part of Australia’s industrial relations system since it was established nearly a century ago. They are representative organisations that campaign on behalf of their members to achieve the best possible working conditions, and which represent employees in negotiations and disputes. They also lobby government in relation to a variety of issues including tax, childcare, and social justice matters.

The peak union body, the Australian Council of Trade Unions (ACTU) plays a key role in wage fixing in Australia through submissions in National Wage Cases (which set minimum rates of pay for award-covered employees) from time to time. Trade unions (especially those that cover professional employees) are also sometimes called ‘professional associations’.

Which union to join?

A union can generally not represent you unless its rules allow it to cover the type of work you do. Which union you join may also depend on whether you are employed in the private or public sector. If there is a union that covers the work performed at your work place, your employer may be able to give you this information. You can also contact the ACTU; most major unions are affiliated with the ACTU.

Once you become a member of a union you are bound by its rules and are obliged to pay membership fees. You will be required to give notice if you intend to resign from the union for any reason, such as if you are no longer going to work in that industry.

What benefits are there in joining a union?

Unions can represent their members in a number of areas, including:

- Negotiating the terms and conditions of awards and enterprise agreements or Australian Workplace Agreements (AWAs) with employers;
- Investigating suspected breaches of award or underpayment of wages;
- Health and safety and workers compensation issues;
- Unfair dismissals;
- Redundancies;
- Sexual harassment and discrimination claims;
- Superannuation;
- Industrial disputes.

These matters often involve dealings with parties such as industry bodies, employer associations or the government, or representation in the Industrial Relations Commission, Equal Opportunity Commission, or the courts.

In addition to their industrial role, unions will usually also provide other benefits for their members that may include discounts on various goods and services, and access to legal and financial advice. The benefits provided will vary from union to union.

Do I have to join a union?

You do not have to join a union. Federal laws make it illegal to coerce anyone to join a union or to deter them from joining a union. It is also illegal to discriminate against a person for choosing to join or not to join a union, or to dismiss them for union membership or non-membership.
Roles of industry personnel

Organisational roles

The roles of people working at different levels within an organisational structure are described below.

Management
Management may be defined as the individual or group responsible for decision making in a firm. It is the task of management to organise and coordinate the process of manufacture from the raw material stage to the sale of the finished product.

Planning
Engineers are responsible for planning and development work, estimating quantities and costs, testing new designs and initiating new processes, calculating material strength or suitability, and for originating plans to a preliminary stage.

Draughtspersons draw up the projected work to accepted standards, making sub-assembly drawings, compiling material lists and specifying work standards.

Processing
Works engineers coordinate production with sales, and, with planning staff, aim at maximum efficiency of the workshop labour and equipment.

Team leaders allocate machine space and labour to ensure continuity of work and supply. They act as liaison between management and the workers.

Tradespersons carry out detailed work from drawings on machine or handwork, set up machinery for process workers and mark out. They are also used for maintenance.

Apprentices assist tradespersons in all branches of their trade, and in so doing learn the skills associated with various aspects of the work.

Semi skilled workers carry out many machining operations, repetitive work and assembly line work.

Labourers are responsible for the general cleanliness of the shop, the movement of materials and general operations where no specialist skills are required.

Packing
Warehouse managers are responsible for the receipt and despatch of finished work or incoming components, and their handling and safe storage.

Storepersons catalogue materials in and out of the warehouse have a ready knowledge of stock. They also allocate areas within the store for stacking of material.

Packers crate or pack the work so that it can be stored or transported conveniently and without damage. Many operate forklifts or loading equipment.
Finance

*Auditors* check and verify accountant's statements, and are directly responsible to the management.

*Accountants* are responsible for keeping all books of account, calculating profits, payment of wages, taxation, and calculating costs of work and material from time cards.

*Bookkeepers* make entries in the books of account to indicate the position of debtors, creditors, etc.

*Clerical assistants* are responsible for correspondence, mailing statements of account and invoices, issuing receipts.

Sales

*Sales managers* are responsible to management for coordinating sales and demand with production. They make personal representation to distributors or retailers to present new products.

*Sales representatives* act as liaison between management and customer. They usually travelling considerably to maintain contact or follow up enquiries or complaints.

*Carriers* are employed by the company for interdepartmental carrying or moving packed goods to retail outlets. *Private contractors* or government carriers may also be used.

*Retailers* sell the manufactured goods to the public and are usually not connected with the manufacturers except in this way. They try to stimulate sales and demand for the profit made on handling the goods.

*Advertising managers* put the product before the public through newspapers, television, radio, etc. in the best possible light to stimulate sales.

Market Research

*Economists* study market and consumer trends and advise management on production and marketing techniques. They study and report on industry's stability, likely economic changes and consequent effects on the company.

Industrial Research

*Research officers* are responsible for the technical control of research and development activities within a firm. They should become familiar with, and test, new techniques under the factory's particular conditions. They should follow trade journals, papers and developments to attempt to improve existing products and designs.
Equity/EEO

What is EEO about?

Equal Employment Opportunity (EEO) is about:

• making sure that workplaces are free from all forms of unlawful discrimination & harassment, &
• providing programs to assist members of EEO groups to overcome past or present disadvantage.

This means having workplace rules, policies, practices & behaviours that are fair & do not disadvantage people because they belong to particular groups.

In such an environment, all workers are valued & respected & have opportunities to develop their full potential & pursue a career path of their choice.

EEO groups are people affected by past or continuing disadvantage or discrimination in employment. As a result they may be more likely to be unemployed or working in lower paid jobs. These groups are:

• women,
• Aboriginal people & Torres Strait Islanders,
• members of racial, ethnic, & ethno-religious minority groups, and
• people with a disability.

Fair practices & behaviour

EEO aims to achieve fair practices & behaviour in the workplace, including:

• recruitment, selection & promotion practices which are open, competitive & based on merit. This means the best applicant is selected for the job,
• access for all employees to training & development,
• flexible working arrangements that meet the needs of employees & create a productive workplace,
• grievance handling procedures that are accessible to all employees & deal with workplace complaints promptly, confidentially & fairly,
• communication processes to give employees access to information & allow their views to be heard,
• management decisions being made without bias,
• no unlawful discrimination or harassment in the workplace, and
• respect for the social & cultural backgrounds of all employees & customers.
As an employee you have the right to:
• a workplace that is free from unlawful discrimination & harassment,
• fair practices & behaviour in your workplace,
• competitive merit-based selection processes for recruitment or promotion,
• training & development that enables you to be productive in your work & to pursue a career path,
• equal access to benefits & conditions including flexible working arrangements, and
• fair processes to deal with work-related complaints & grievances.

You have the responsibility to:
• work to the best of your ability & provide quality service to customers,
• recognise the skills & talent of other staff members,
• act to prevent harassment & discrimination against others in your workplace,
• respect differences among your colleagues & customers such as cultural & social diversity, and
• treat people fairly.

As an employer
You have the same rights & responsibilities as staff members & you also have the responsibility to:
• take steps to ensure that all work practices & behaviours are fair in your workplace,
• ensure the work environment is free from all forms of unlawful discrimination & harassment,
• provide employees with information & resources to enable them to carry out their work,
• consult employees about decisions that affect them,
• provide all employees with equal opportunity to apply for available jobs, higher duties, job rotation schemes & flexible working arrangements,
• ensure selection processes are transparent & the methods used are consistent,
• provide all employees with equal access to fair, prompt & confidential processes to deal with complaints & grievances,
• give your employees equal access to relevant training & development opportunities,
• identify special training & development needs of EEO group members in your team & help them gain access to training & development opportunities, and
Who benefits from EEO?

**Employees benefit by:**
- working in a fair environment which is free from unlawful discrimination & harassment,
- equal access to jobs, training & other developmental opportunities
- fair processes to deal with work-related complaints & grievances, and
- increased employee job satisfaction & morale

**Employers benefit by:**
- a more productive & co-operative workplace,
- the selection of the best applicants improves the efficiency of the organisation,
- skilled staff are retained, and
- improved quality of work.

A workplace which is fair & free from unlawful discrimination & harassment is more productive & better able to meet its business goals.

**Customers benefit by:**
- an efficient & effective organisation
- services which are responsive to the needs of a diverse market.

**Legislation**

The NSW Anti-Discrimination Act 1977

**Federal laws**
- Age Discrimination Act 2004
- Disability Discrimination Act 1992
- Human Rights & Equal Opportunity Commission Act 1986
- Racial Discrimination Act 1975
- Sex Discrimination Act 1984
Occupational health & safety

Government legislation (OHS)

Legislation is the law determined by the government, the legislation covering OH&S in NSW is administered by the WorkCover Authority of New South Wales. The legislation consists of Acts of Parliament and regulations made under those Acts, and is supported by codes of practice and standards.

Acts

The principal Act relevant to workplace health and safety in NSW is the *Occupational Health and Safety Act 1983*.

Some legal requirements are contained in associated legislation, including:

- *Construction Safety Act 1912*
- *Dangerous Goods Act 1975*
- *Factories, Shops and Industries Act 1962*
- *Rural Workers Accommodation Act 1969*

Regulations

A number of regulations operate under the OH&S Act 1983 and associated legislation. Regulations give detail on how certain sections of the Act are to be implemented.

Some regulations made under the OH&S Act’s are:

- *Occupational Health and Safety (Committees in Workplaces) Regulation 1984*
- *Occupational Health and Safety (Inspectors’ Notices) Regulation 1988*
- *Occupational Health and Safety (First Aid) Regulation 1989*
- *Occupational Health and Safety (Manual Handling) Regulation 1991*
- *Factories (Health and Safety) General Regulations*
- *Factories (Health and Safety- Circular Saws) Regulations*
- *Factories (Health and Safety- Hearing Conservation) Regulations*
- *Factories (Health and Safety- Spray Painting) Regulation*
- *Timber Industry (Health and Safety) Regulations*
Industry requirements (standards)

Standards are issued by Standards Australia and by Worksafe Australia. Those issued by Standards Australia set out specifications for a range of equipment, products and materials to ensure that they are safe and of good quality. The ‘Standard Mark’ is then shown on them. Many of these standards are ‘called up’ in legislation, meaning they have to be used and are legally binding.

For industry to operate effectively and efficiently there is a need for certain industry standards to be set. These standards govern the way an industry operates in much the same way as standards for road use (the ‘rules of the road’) govern how people drive on the roads. Some standards are developed by industry to assist in the smooth and safe operation of that industry, while other standards are set by government and cover all industries.

One of the most important standards for any industry is government legislation relating to safety in the workplace.

In NSW, the Department of Industrial Relations represents the government in formulating structures relating to Occupational Health and Safety. Correspondingly, WorkCover as a statutory authority has the responsibility for enforcing legislation and providing educational support for the legislation.


The legislation contains provisions that require the employer to consult with employees on issues of safety, health and welfare. It applies to large and small business and also to the self employed.

Industry standards may be described in the form of duties and categorised as responsibilities. In the case of Occupational Health and Safety:

1. The responsibilities of the employer include:
   - ensuring that the places of work under their management are safe
   - ensuring that risk management procedures for the safe use, handling, storage and transport of plant materials are established for their workplace
   - ensuring that systems of work and the work environments are safe, without risks to health
   - ensuring that information, instruction, training and supervision is provided to support the safety of employees
   - ensuring the provision of adequate facilities for the welfare of employees.

2. The responsibilities of the employee include:
   - taking reasonable care of the health and safety of themselves and others
   - cooperating with employers in their efforts to comply with occupational, health and safety requirements.

Breaches of the legislation can result in serious penalties for an individual and the business.
<table>
<thead>
<tr>
<th>Issue</th>
<th>Employer</th>
<th>Employee</th>
</tr>
</thead>
<tbody>
<tr>
<td>OHS obligations</td>
<td>• Take all reasonable steps to protect the health and safety at work of its employees.</td>
<td>• Co-operate with the employer to the extent necessary to enable the employer to fulfil its obligations under the Act.</td>
</tr>
<tr>
<td>work environment</td>
<td>• Provide and maintain a working environment that is safe and without risk to employees’ health.</td>
<td>• Not take any action, or make any omission that creates a risk to the health and safety of the employee or other persons (whether employees or not) at or near the place at which the employee is at work.</td>
</tr>
<tr>
<td>work methods and practices</td>
<td>• Ensure safety and the absence of risk at work to the health of its employees in connection with the use, handling, storage or transport of plant and substances.</td>
<td>• Use equipment in accordance with instructions given by the employer consistent with its safe and proper use, that is necessary to protect the health and safety of the employee, or of other persons at or near the place at which the employee is at work.</td>
</tr>
<tr>
<td>welfare and facilities</td>
<td>• Provide adequate facilities for employees’ welfare at work.</td>
<td></td>
</tr>
<tr>
<td>access and egress from the workplace</td>
<td>• Provide and maintain a means of access to, and egress from the workplace, that is safe for employees and without risk to their health.</td>
<td></td>
</tr>
</tbody>
</table>
First Aid

First aid equipment, personnel and facilities are important resources in assisting workplaces to manage workplace injuries and illnesses.

• OHS Regulation 2001 sets out specific first aid requirements for certain types of workplaces. However every workplace has a legal responsibility for ensuring adequate first aid provisions.
• First aid provides the initial and immediate attention to a person suffering an injury or illness.
• In extreme cases, a quick first aid response could mean the difference between life and death.
• In many cases, first aid can reduce the severity of the injury or illness.
• A quick and competent first aid response also calms the injured person, reducing unnecessary stress and anxiety.

It is recommended that access to first aid personnel is available wherever there are more than 25 persons at a workplace, regardless of whether or not those persons are employees.

What is First Aid?
First aid is the initial care of the injured or sick. It is the care administered by a person as soon as possible after an accident or illness. It is this prompt care and attention prior to the arrival of the ambulance, that sometimes means the difference between life and death, or between full or partial recovery. Immediate action is the main principle to be adopted in first aid. The Australian Legal system recognises that everyone has a ‘duty of care’ towards others and provided that any care and treatment undertaken for the good of the casualty, that no deliberate harm was caused, and that the incident was handled as if by a reasonable person, then the provider should have no fear of litigation. (Active First Aid 4th Edition, I Wilson & P McKie)

The aims of first aid

First aid aims to:
- Promote a safe environment
- Preserve life
- Prevent injury or illness from becoming worse
- Help promote recovery
- Protect the unconscious
- Reassure the ill or injured.

The first aider aims to prevent:
- Further danger to himself, others or the casualty
- The casualty dying
- The casualty’s condition becoming worse
- Delay in the casualty’s recovery
- Any harmful intervention.
Safety training & human factors

An organisational training needs analysis shall be conducted in consultation with the OHS&R Coordinator. This analysis shall take into account:
(i) the training requirements detailed under each procedure in this manual.
(ii) any proposed changes to work organisation, roles or responsibilities.
(iii) any other risks or requirements that may be identified in consultation with (iv) managers and employees.

A training needs analysis shall be conducted for each employee. This analysis shall take into account:
(i) legislative requirements,
(ii) knowledge and skill requirements of their work role,
(iii) responsibility statements and position descriptions,
(iv) needs and skills of current employees.

A training program shall be developed, taking into account training providers and training programs currently available. The training plan shall consider one-off training, as well as refresher training.

The development of an annual training schedule shall form part of the annual OH&S Management Plan.

Training records shall be kept to demonstrate legislative compliance and enable monitoring of the training plan on both an organisation and an individual employee basis.

The records shall cover:
(i) who has attended training,
(ii) when the training course took place,
(iii) who provided the training,
(iv) a brief outline of the objectives, duration, content and evaluation.

The OHS&R Coordinator in consultation with the OH&S Committee shall review the effectiveness of the training program annually.

A budgetary allowance shall be made to enable achievement of training targets.

Development of the training programs and selection of the training provider(s) shall take into account the needs of any employees with non-English speaking backgrounds.
This diary is a safety publication that goes to work for a whole year informing and motivating for improved health and safety at work. It is ideal for all employees who attend workplace health and safety meetings.

The OH&S Diary gives guidance on how to have successful meetings. Space is allocated to write down the committees’ mission statement, to list all the members contact points and to document the year’s objectives. Each month has a safety theme such as machine safety, electricity, fall prevention and emergency response with checks to help ensure health and safety at work.

Go Safety Posters are designed to make people at work STOP and THINK about a given OHS topic. The Go Safety Logo on each poster provides a constant reminder to people about the right attitude to adopt to help protect people and property from harm. The success of any OHS plan rests on how well employees buy into it (or not). As with any effective sales campaign, if you want to sell OHS you must do some advertising.

Go Safety Posters retain their impact when they are interchanged and varied throughout the year. You can measure their impact in terms of reduced accident rates and feedback from employee surveys, asking them specific questions about your safety promotions as well as getting data from inspections.

Go Safety booklets cover a whole range of OHS topics and new titles are being added to the range to make safety training even easier. Go Safety Booklets are written in a friendly and easy-to-read style and are ideal for educating and motivating your employees on critical OHS issues.
Materials handling & Workplace safety

Manual handling means any activity requiring the use of force exerted by a person to lift, lower, push, pull, carry or otherwise move, hold or restrain a person, animal or thing.

Manual handling also includes any activity involving repetitive and/or forceful movements (eg. keying data into a computer; using a screwdriver) and any activity where the person must maintain constrained or awkward postures (eg. driving a truck; leaning over to make beds).

**What are the present weight limits for lifting?**

There is no longer a prescribed maximum weight limit for lifting for either men or women.

The weight of the load needs to be considered in relation to a number of other risk factors such as the:

- actions and movements
- working posture and position when lifting
- duration and frequency of manual handling
- location of loads and the distances moved
- characteristics of the load.

Light loads can still be a problem if for example they are lifted incorrectly or if light loads are lifted in an environment that is unsafe.

The National Code of Practice: Manual Handling indicates that the risk of injury increases when:

- lifting weights of more than 4.5 kg while seated
- lifting weights above the range of 16-20 kg.
  
  (weights over 55 kg should not be lifted without mechanical assistance or team lifting.
- pushing, pulling and sliding objects that are difficult to move.

Young workers under the age of 18 years should not be required to lift, lower or carry more than 16 kg without mechanical or other assistance and/or particular training for the task.

**Can my employer force me to lift something that is too heavy for me?**

Employers in NSW must comply with the requirements of the *OHS Act 2000* and the *OHS Regulation 2001*.

In NSW, employers:

- must ensure the health safety and welfare of their workers
- have a duty to consult with workers over OHS issues
- must undertake hazard identification, risk assessment and control, in consultation with those workers who are required to carry out the manual handling tasks. This a legal requirement.

The National Code of Practice: Manual Handling provides practical advice in meeting the requirements of the National Standard for Manual Handling in relation to the identification, assessment and control of risks arising from manual handling in the workplace.
If consultation has not taken place or has not resulted in safe manual handling procedures then, practically speaking, the worker can:

- talk directly to management or a supervisor about the problem
- bring the problem to the attention of the OHS committee (if existing)
- contact the industrial union (if a member)
- if all else fails, contact the local WorkCover office.
The type of products depend on the work being done. Products can be located via the Yellow Pages and the internet and include:

- back saver cranes;
- castors;
- drum handling;
- forklift attachments;
- hand trucks;
- lift tables;
- load skates;
- pallet lifters;
- stair climbers;
- tailgate loaders;
- tool balancers;
- trolleys;
- utility cranes;
- vacuum lifters;
- wheels; and
- work stands.

**What is personal protective equipment?**

Personal protective equipment (PPE) is any clothing, equipment or substance designed to protect a person from risks of injury or illness.

PPE can include:

- ear muffs and ear plugs
- respirators
- eye and face protection, such as goggles
- safety helmets and sun hats
- gloves and safety boots
- clothing, such as high visibility vests or life jackets
What are an employer's obligations in relation to manual handling under the Occupational Health and Safety Regulation 2001?

Employers must:
- identify any foreseeable hazards arising from manual handling (including the potential for occupational overuse injuries)
- assess risks from hazards that are identified
- eliminate any risks or, if not reasonably practical to eliminate the risk, design the work activity involving manual handling to control the risk and, if necessary, modify the design, provide mechanical aids for team lifting and ensure correct use of aids and training in manual handling techniques (clause 80(2)).

When assessing risks, employers must:
- evaluate the significance of the hazard
- review relevant and available health and safety information (as listed)
- identify factors contributing to the risk
- identify actions necessary to eliminate or control the risk
- identify records that are necessary to be kept.

Employers must also review a risk assessment whenever:
- there is evidence that the risk assessment is no longer valid
- injury or illness results from exposure to a hazard to which the assessment relates
- a significant change is proposed in the work or work practices to which assessment relates.

When eliminating and/or controlling risks, employers must:
- ensure that all measures that are adopted to eliminate or control risks to health and safety are properly used and maintained.

Chapter 2 of the regulation also specifies employer obligations in relation to the provision of:
- instruction, training and information
- supervision
- personal protective equipment.

Employers must also obtain information necessary for them to fulfil their responsibilities under the Regulation.

Chapter 4 of the OHS Regulation 2001 relates to the employer’s obligation to eliminate and control risks arising from the manual handling of loads.

In eliminating risks, employers must ensure that:
- all objects are, where appropriate and as far as reasonably practicable, designed, constructed and maintained so as to eliminate risks arising from manual handling
- work practices are designed so as to eliminate risks arising from manual handling
- the work environment is designed to be, as far as reasonably practicable, and to the extent that is within the employer’s control, consistent with the safe handling of loads.
In controlling risks, employers must:

- modify the design of the objects to be handled or modify the work environment taking into account work design and work practices
- provide mechanical aids, or make arrangements for team lifting, or both
- ensure that persons carrying out the activity are trained in manual handling techniques, correct use of mechanical aids and team lifting procedures appropriate to the activity.
What training should be provided to workers and management regarding manual handling?

Training should not be seen as a risk control strategy on its own – it supports other control strategies. However, training is essential if manual handling risks cannot be eliminated. Under the OHS Regulation 2001, an employer must ensure that each new worker receives induction training that covers the following:

- arrangements for managing OHS, including reporting hazards to management
- workplace health and safety procedures relevant to the worker, including the use and maintenance of risk control measures
- how workers can access health and safety information that the employer is required to make available.

Employers must ensure that any person who may be exposed to a risk to health and safety:

- is informed of the risk
- is provided with any information, instruction and training necessary to ensure the person’s health and safety.

The information, instruction and training (and the timing of that training) must also be commensurate with the risk to health and safety concerned.


There are also two types of training mentioned in the National Code of Practice: Manual Handling – general training and particular training.

**General training**

General training in manual handling is designed to:

- prevent manual handling injuries through risk identification, risk assessment and primary control through job and task design
- increase awareness and understanding of the complex nature of manual handling activities
- teach safe manual handling techniques.

This training should be provided to workers involved in manual handling, and also to the managers and supervisors of these workers, worker representatives, and staff responsible for work organisation, job and task design.

**Particular training**

Particular training is designed to help workers manage a specific task that has been identified as a risk and which requires a specific method to do it safely. Any such training provided to employees should also be provided to their supervisors.

WorkCover NSW has an accredited Manual Handling Training Course, which provides general training in the risk management of manual handling. It is delivered by WorkCover accredited trainers.
Ergonomic workstations for keyboard operators

Prolonged work at a computer can strain your arms, neck, hands and back. In most cases, health problems occur because of a poorly designed or setup workstation.

A well designed workstation considers your chair, lighting, noise, and the position of the screen, keyboard and documents.

Ways to control hazards

- Assess work methods and workplace setup, and implement ergonomic workstations for keyboard operators.
- Use an ergonomically designed chair with:
  - a height adjustment (from the floor)
  - an adjustable back rest (in height, angle and depth)
  - a curved seat edge
  - cloth covered seat and back
  - a five-star castor base.
- Adjust the seat so your feet rest firmly on the floor. Take your weight through your feet.
- Adjust the back rest of the chair so you sit in a position where your thighs are fully supported, except for a two-finger width space behind the knee.
- Maintain a relaxed posture, especially in your shoulders and neck:
  - Keep elbows by your side.
  - Keep forearms and hands parallel to the ground (with about 90 degree angle at the elbow).
  - Do not bend or cock your wrists when typing.
  - Sit at a comfortable distance from the keys (the length of your forearm away).
- There is no single height of a monitor which is suitable for all users. Some people find looking down slightly more comfortable than having the top of the screen at eye level. The height and angle of the monitor affects the gaze angle and inclination of the head. With the newer thinner LCD monitors it is now possible to have a monitor that is about arm’s length away. The best advice is to avoid extremes of head and neck bending, avoid having to look up at a screen (as this requires the head to be tilted backwards and places pressure on the neck) and arrange you monitor so that you feel comfortable.
- Position documents and the screen about the same distance from your eyes. Use a document holder to place the documents:
  - in a level position beside the screen (when the keyboard is in a central position) or
  - directly below the screen, just above the keyboard.
- Position the screen directly in front of the keyboard if you spend most of the time looking at it. If you spend most of the time looking at a document, place the document directly in front of the keyboard.
- Place the screen at right angles to a window. Alter the angle of the screen to avoid glare and reflection, or use blinds, curtains or screens to block glare.
• Ideally, place screens parallel to overhead fluorescent lights (to avoid rebound reflection).
• Adjust the contrast of text and background on the screen to a moderate level.
• Rest your eyes occasionally. Look out a window or at a wall poster.
• When typing, take short breaks of 30 - 60 seconds. Relax your hands in your lap or on the desk. Change the activity to relieve fatigue. Stand or walk about. Vary your posture as much as possible.
• Remove or control distracting noises. Use acoustic hoods over printers, remove noisy equipment from the work area or use quiet air conditioners.
• Provide adequate ventilation to the work area to counter the heat generated by computers and associated equipment.

Like all electrical equipment, computers emit electromagnetic radiation however the low level is not considered a health risk.
Ergonomic considerations for the office environment

Detailed ergonomics for setting up a computer workstation
Workplace culture

Why workplace culture is important

Making work-life balance policies available is an important step in helping employees balance their work and personal lives. However, these policies will be ineffective when employees feel inhibited or are prevented from using these policies.

When introducing policies aimed at helping employees balance their work and personal lives, it is important to ensure that the workplace culture supports employees’ use of these policies.

A supportive workplace culture has been associated with a variety of benefits for both employees and employers, including higher levels of affective commitment to the organisation, lower intention to leave the organisation, higher levels of job satisfaction, lower levels of stress and the experience of less conflict between work and family responsibilities.

In addition to the direct positive effects of a supportive workplace culture, perceptions of a supportive workplace culture are associated with greater utilisation rates of work-life balance policies. The culture in the organisation is crucial for determining whether employees will use the policies and their general attitudes towards the organisation. For employees and employers to enjoy the benefits of work-life balance policies, the culture and work environment need to be addressed when implementing such policies.

So, just offering the policies is not sufficient as employees need to feel comfortable using the policies. Both managers and colleagues can make employees feel uncomfortable using benefits. Family-friendly policies will be useless or counterproductive if the work culture does not support them.

How to change workplace culture

The development and implementation of policies is a gradual process, which requires dealing with certain behaviours, attitudes and expectations held by employees and management within the organisation.

Three ways of changing workplace culture may include:

- Education and communication
- Getting management behind the culture change
- Changing key values and norms and cultural artefacts

Education and communication

Changing the workplace culture does not happen overnight and requires commitment from both employers and employees. It is important to build consensus for culture change from the top down as well as the bottom up. Education about the importance of work-life balance, the benefits provided by work-life balance policies and the role of workplace
culture is necessary to convince managers and front-line employees of the importance of a supportive ‘work-life balance’ culture.

Discussions between management and staff may increase understanding of mutual expectations and develop solutions to work-life balance issues. Discussions between team members on how they can help each other with work-life balance should be encouraged, as it provide employees with a feeling of ownership of the problem solving process.

Getting managements' support

It is vitally important that both senior and middle management get behind the culture change. Active and visible support from senior management is crucial to the effective introduction of work and family policies. Managers supporting a traditional organisational culture, which emphasizes the pursuit of work goals and ignores employees' personal lives, undermine the success of work-life balance policies.

Managers should be a role model for their employees by using work-life balance policies themselves. It is very important that managers use policies in an appropriate way, so employees are given accurate information on how the policy is supposed to work.

For example, employees have a right to use up to ten days paid sick leave per year to care and support family or household members who are ill. If a manager then stays at home to care for a sick child, but uses annual leave, he/she sends out a wrong message that while it is ok to stay at home due to caring responsibilities, it should be at the detriment of your own recreational leave. The manager has a right to ten days paid carer’s leave and should set the right example by using the right type of leave.

Attitudes and resistance of middle management and line managers can create significant barriers to employees use and effectiveness of policies. Middle and line managers are particularly important in the change process as they are more directly in touch with the work environment of the employees. Implementation of policies will be more effective if line managers are convinced of the need to implement the policies. Line managers need to know why policies are introduced and how they will improve organisational performance.

Changing key values and norms and cultural artefacts

An important issue that should be addressed when trying to change the workplace culture is the role of so-called “cultural artefacts”.

Cultural artefacts are the characteristics of an organisation that reflect and support its workplace culture. The most important cultural artefact is the organisation’s key values and norms. Other cultural artefacts are myths and sagas about company successes and heroes and heroines; symbols, rituals and ceremonies; and use of physical surroundings. It is important when changing the workplace culture, to change the existing cultural artefacts as well. New cultural artefacts can enhance the change process.
One of the most important key values and norms that are likely to undermine work-life balance policies is the belief that work and personal lives should be completely separated.

When trying to change the workplace culture, it is most critical to address the key values and norms. It is important for organisations to think about the key values and norms the existing organisational structures and practices communicate to employees.

For example, some organisations may send out messages about the organisation’s key values and norms through its reward system. Organisations may indirectly reward not using work-life balance policies when they provide rewards purely based on the number of hours worked, instead of employees’ outputs and performance. Employees may feel pressured to work long hours out of fear that their career will suffer, making it more difficult to attend to responsibilities in their personal lives.

The organisation could change its reward system by putting a greater focus on output and performance instead of work hours. The organisation could also consider including a statement on the organisation’s commitment to work and life balance in the organisation’s Value Statements, which outlines the core values, as this may help reinforce work-life balance as a key value of the organisation.

Changing key values and norms may prove very difficult. However, the other cultural artefacts may assist in this process.

To help change the key values and norms of an organisation, consider changing other cultural artefacts. These other cultural artefacts include myths and sagas; symbols, rituals and ceremonies; and use of physical surroundings.

**Myths and sagas:**

- A common myth about work-life balance issues is that it is only relevant to women. Educating people about the benefits of these policies for both women and men may help change this common myth.
- Organisations could give profile to people in the organisation who are high performers and who also use the policies to create new heroes and heroines.

**Symbols, rituals and ceremonies:**

- The organisation could organise some social functions at times suitable for children as well as adults and specifically invite the employees’ family members.
- The organisation could introduce awards for managers or supervisors nominated by employees for having provided an environment where both employees’ work productivity as well as their personal needs are addressed and enhanced.
- The organisation could have award ceremonies for those employees who are playing an important role in changing the workplace culture.

**Use of physical surroundings:**

- Allow people to have pictures or other personal objects in their work area.
Workplace communication

Signs and symbols are used in a workplace to convey information to workers and visitors to the site. Being able to move or navigate around the workplace independently and safely to perform tasks or access meal and bathroom facilities can be critical to an individual’s success and productivity at work. There are a range of signs in the workplace that allow a person to move around safely and with confidence.

Safety signs

There are three main types of safety signs used in the workplace:

1. Picture signs using symbols or pictures.

2. Signs with only text based messages.

3. Picture signs with a short message.

Picture signs are used as they reach as many people as possible in the workplace, including workers with low reading ability or people from non-English speaking backgrounds.
Colour and shape

There are seven categories of safety signs identified by colour and shape:

1. Prohibition signs – these are signs that indicate something that you must not do: They are made up of a red circle border with a line through it, a white background and black symbol

2. Mandatory signs – these signs tell you that you must wear some special safety equipment: They are made up of a blue solid circle, white symbol, with no border.

3. Restriction signs – these signs tell of a limitation placed on an activity or use in the area concerned. They are made up of a red circular border, no crossbar, and a white background.

4. Hazard warning signs – these signs warn you of a danger or risk to your health: They are made up of a yellow triangle with a black border, and a black symbol.
5. Danger hazard signs – these signs warn of a particular hazard or hazardous condition that is to be life-threatening: They are made up of a white rectangular background, with the word DANGER in white on a red background, and black border and black text.

![Danger Sign](image)

6. Emergency information signs – these signs show where emergency safety equipment is kept: They are made up of a green solid rectangle, with a white symbol or text.

![Emergency Sign](image)

7. Fire signs – these signs tell you the location of fire alarms and firefighting facilities: They are made up of a red solid rectangle, with white text.

![Fire Sign](image)

Activity one

Use the [www.adeptsafetyonline.com.au](http://www.adeptsafetyonline.com.au) website to find the following safety signs.

1. STRICTLY NO ADMITTANCE
2. DANGER 240 VOLTS
3. DISABLED TOILET
4. HIGH VOLTAGE
5. EMERGENCY EXIT
6. FIRST AID
7. EYE PROTECTION REQUIRED
8. BEWARE OF VEHICLES
9. WATCH YOUR STEP
10. NO SMOKING IN THIS AREA
Section B – Design & Management

Designing
- research and analysis
- elements
- sequence planning
- material suitability and selection

Drawing
- interpretation
- sketching
- production

Computer applications
- computer software related to management and development of folio and project; see also management folio

Project management
- planning
- documentation
- group activities
Design
- identifying a problem, finding the best solution and realising the solution.

Good design – SAFE
S  simple
A  appropriate - the design must fit the situation in which it is to be used
F  functional – how the design works, & how well it works in a given situation
E  economical – the cost to the consumer, to society and the environment

The design process – DESIGNED
D  define the problem  statement of intent
     requirements, limitations and scope of the problem
E  establish ideas  come up with ideas – ideation
S  select an idea  one design is selected as the best for now
I  investigate the best idea  drawing, prototypes, models, market research
G  go or stop  feasibility study – proceed or not
N  new idea  the production process begins to produce the new design
     Resources are organised to achieve effective production
D  done  successful completion
Research and analysis

There is no guaranteed formula for successful research. However, conducting effective research and accurate analysis is an essential part of fulfilling any design brief. Without it, the designer starts without any idea of how others solved similar problems in the past. This would necessitate the designer spending many hours solving basic problems without using or improving upon existing solutions. Many researchers spend a significant amount of their time reading because we can learn a lot more quickly from other people’s work than from doing your own fundamental research. Although the majority of the research is conducted before a design solution is determined, the research process should continue throughout the design process in much the same way as a good designer continually evaluates her/his solutions.

The types of information required may include:

- providing general background information
- identifying existing ideas or solutions which are similar to the design brief
- identifying solutions to specific design or construction problems.

The amount of information you could read to have a solid understanding in any field may seem intimidating. Knowing where to look for both general and specific information can make research more efficient and effective.

Sources of information

It is useful to start with a general field of enquiry and gradually become more specific. This is commonly called working from the tertiary sources, through secondary sources to primary sources.

Tertiary sources of information are reference books or textbooks. They can offer a broad summary of a field of study. They are usually reliable, as they have been compiled from a number of other sources and have been thoroughly researched and are generally considered as authoritative. Try to use recently published textbooks as older publications can offer out-of-date information, particularly in the technology field. Textbooks may contain further references to associated material.

Secondary sources of information include summaries of information found elsewhere. Encyclopaedia articles and other publications containing factual information are examples. These sources have the advantage of being current and the information has usually been verified by another source.

Primary sources of information include reports from experiments, investigations and articles in trade journals or on the Internet, first hand accounts and original works. These are usually up-to-date but may offer inaccurate information.
Where to look

The most common places to look for information include:

- the Internet
- libraries
- books
- related magazines
- journals
- the electronic media, e.g. CD-ROMs

How to look

1. Identify your idea, image or question.
2. Scan resources such as books, journals, web sites, etc. to see if they are relevant.
3. Use the table of contents, index or find function to quickly locate useful information.
4. Highlight interesting ideas as you find them. Highlight different concepts in different colours, such as design shapes in blue, finishes in yellow, etc.
5. Make notes of your thoughts, questions and ideas as you go. Keep a notebook for this purpose.
6. As you get some ideas, narrow your research question(s) and do further research.

Collecting and organising researched information

It is a good idea to keep an ongoing research notebook. Different systems work for different people. You might keep it as computer files, in a spiral notebook or on note pads. Find a system that suits you best.

Record in your notebook ideas as they come up. The information collected can be stored at random. The information could be written notes, images, sketches or mind maps. Record your speculations, current problems with your work and the possible solutions. Also note areas of future research.

Read back over your notebook periodically. What you put in your notebook will document your research and problem solving processes.

A mind map is a very visual way of showing the relationships between ideas, expanding from a central “hub” which is the main theme. A mind map can often look like a web, or an octopus. Mind maps offer the advantage of providing a non-linear and creative way of recording ideas on paper. Mind maps help you focus on the central theme and visualise the meaning behind the words. They can be either words or images or a combination of both.

How to make a mind map

1. Draw a colourful picture for the main idea in the centre of the page.
2. Draw lines out of this to create an expanding web of ideas.
3. Use fewer words and more pictures.

Alternatively, you can use a program such as CMAP
Using the Internet

The key things to remember about using the Internet for research are:

- There is more to the Internet than web pages. Many sites have multiple pages and other web links.
- Finding good material is often best done using search engines or metasearch engines.
- Learning how search engines work can help you to search more effectively.
- No one search engine, directory or database contains a list of everything on the web.

Is the source reliable?

The sources of information found on the Internet vary in reliability. The letters at the end of the URL indicate the organisation type and the country of origin. If there is nothing after the organisation type, the country of origin is the United States of America. Researchers must use discretion when evaluating information from different organisations. Educational (.edu) and non-profit organisations (.org) are generally good places to start research.

Wikipedia includes a disclaimer notice if the source of its articles is not verified.

Libraries

Libraries commonly contain books, magazines, encyclopaedias, handbooks, atlases, newspapers, journals and audio-visual materials. Most libraries offer Internet access. They can also arrange loans from other libraries if they do not carry a specific item you wish to view.

To locate source material for a particular topic, use the library catalogue systems. Remember to check the shelves for other sources that have the same classification number as the book you are seeking as they often contain useful materials. These books are commonly found with Dewey classification numbers immediately above or below the original item you were seeking.

Librarians are available to offer assistance as required.

Using audiovisual media

Viewing audiovisual recordings can generate many design ideas or provide solutions to design problems. These are available via library collections or can be viewed on free-to-air or pay television.
Elements

Awareness of, and an understanding of the principles of design are essential when planning the production of any project.

The design of a new product, or the redesign of an existing product is usually a response to a need and the analysis of this need in the context of the final use of the product.

Good design will be a balance of many elements, which may include,

- **function** – does a product effectively and efficiently carry out the task that it is designed to carry out?

- **aesthetics** – this is what a product looks like. It is an emotional response based on how appealing an individual finds the design. Components such as visual appeal, proportion, colour, texture, help determine whether we judge an item to be aesthetically pleasing or not. The old adage, beauty is in the eye of the beholder, may be quite true when we consider the aesthetic appeal of a design.

- **ergonomics** – is concerned with the human factors that need to be considered in a design. The web site [http://www.ergonomics.org.uk/](http://www.ergonomics.org.uk/) provides a good explanation of the aspects of ergonomic design. Some examples of poor ergonomic design can be seen at [http://www.williamson-labs.com/480_ergo.htm](http://www.williamson-labs.com/480_ergo.htm)

- **safety** – safe use and operation are essential considerations when designing many products. This is particularly crucial in the design of products for babies or children or where electricity is involved. All aspects of a design need to be assessed for risk and any potential dangers removed or at least minimised.

- **durability** – how long a product lasts will depend on the quality of the materials used to make it, how well it is made, and on the overall quality control and testing carried out during manufacture.

- **ecology** – sustaining our environment, by reducing waste and caring for our resources is becoming more important to designers. Many products today are developed using ecodesign considerations and undergo life cycle analysis to minimise their impact on the environment and to ensure sustainable resources for the future.
Sequence planning
Material suitability and selection
Computer software applications, design & management

This focuses on the utilisation of computer software applications in the development of the management folio.

Project management documentation consists of all the records, including the management folio, used to complete a major project, and are generally stored as both hard and electronic copies. In addition to the management folio, other forms of project management documentation can include, for example:

- a weekly diary where day to day ‘work in progress’ activities are recorded,
- concept sketches and more formal production drawings of the major project, and
- digital records of construction activities.

The management folio

The management folio is a significant piece of project management documentation because it forms a record of process and review. Therefore it should be an accurate record of all the activities which are addressed and considered during the design and construction of a major project. It includes for example, initial research and analysis activities, production planning, material selection, production drawings of the major project, together with explanations and justifications for each of the decisions taken during the project’s design and construction.

Computer software applications can be used to develop the management folio by integrating it with the other forms of project management documentation enhancing the presentation and quality of the document’s final desktop publication.

Computer software applications

The most common computer software application used to develop the management folio is the word processor. The use of word processing software provides a powerful and flexible editing tool for developing and revising the management folio as the project progresses. While the word processed document will form the foundation of the management folio, many other software applications can be used to generate relevant ‘items’ which can then be integrated into the final document. These include, project management software, spreadsheets, scanned images, Computer Aided Drawings (CAD), graphics, and database software.
The management folio can be efficiently developed by first creating a template file. Some of the basic issues that should be considered when creating this file are set out in Table 1.

<table>
<thead>
<tr>
<th>Page size</th>
<th>Generally A4 with portrait orientation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identity</td>
<td>Think about the manner in which you will identify this document as your own. Consider the insertion of your own logo in either the header or footer. Maybe your ‘logo’ can be incorporated into the splash screen.</td>
</tr>
<tr>
<td>White space</td>
<td>Endeavour to balance the space taken up with text and tables with ‘white space’ or blank space.</td>
</tr>
<tr>
<td>Page layout</td>
<td></td>
</tr>
<tr>
<td>• Margins:</td>
<td>Top, Bottom, Right: 2 cm, Left 2 cm</td>
</tr>
<tr>
<td></td>
<td>Gutter: 1 cm (permits binding)</td>
</tr>
<tr>
<td>• Font selection:</td>
<td>Use a minimum of font types throughout the document. Paragraph text should be in 12 point. Headings can be in a different font using 14 point. For example:</td>
</tr>
<tr>
<td></td>
<td>Arial 14</td>
</tr>
<tr>
<td></td>
<td>Century Gothic 14</td>
</tr>
<tr>
<td>• Line spacing:</td>
<td>Text should be spaced at either single or 1.5 lines.</td>
</tr>
<tr>
<td>• Headings:</td>
<td>Headings should be spaced at 2 lines.</td>
</tr>
<tr>
<td>• Page numbers:</td>
<td>Each page of the body of the document must be numbered. Ideally the page number should be placed at the top or bottom right hand corner on each page.</td>
</tr>
<tr>
<td>Colour</td>
<td>Use colour for images only.</td>
</tr>
</tbody>
</table>

Table 1: Basic template issues. Taken from Barlow, J. 2006). Notes on the Preparation of a Design Record. ACU: Sydney.

Spreadsheet software applications are perhaps the next most accessible software application tools which can support the development of the management folio. They are very versatile and can also be used as substitutes for more sophisticated project management software which can be easily misused if the project management concepts underlying them are not understood.

Spreadsheets can be used to generate project budgets and project planning and control tools like Gantt charts. The Gantt chart in figure 1, for example, was generated using spreadsheet software. It was then simply copied from the spreadsheet and pasted directly into this document.
More sophisticated Gantt charts presentations can also be generated using Microsoft Project. This is a far more complex software package, but is capable of creating a very comprehensive planning tool.

Relevant information collected in the weekly diary, such as evolving annotated concept sketches for example, can be scanned and then inserted in the management folio. Electronically inserting concept sketches, like those shown in figure 2, significantly enhances the authenticity and quality of the completed management folio.

Figure 2: Annotated concept sketches of a chair: Caborn, C. et al 1989, *Design and Technology*, Nelson, p. 96.

Computer Aided Design software applications not only provide a relatively easy to use tool for producing detailed production drawings but can also generate 3D models of the
intended final project which can be inserted in the management folio. An example is provided in figure 3.

![Production drawing with 3D model](http://valens.se/images/draw1.jpg)

**Figure 3:** Production drawing with 3D model (http://valens.se/images/draw1.jpg)

The use of digital cameras is a very common means of recording the construction sequence of the final project. Graphics software applications can then be used to edit these recordings before insertion in the management folio. This can include for example, the cropping (cutting off) of unnecessary background information.

Database software applications can be very useful research tools. Many firms produce their product catalogues as databases and distribute them on CDs which can then be loaded onto a computer for use. Other databases may be accessible on-line. However while there are many relevant on-line databases, they often require a username and password which restricts access.

**Remember also:**

- Use the grammar and spell checker provided in the word processor software application regularly to check written expression. Do not use ‘messaging’ notation.
- Identify all objects, such as graphs, figures, images, photographs and tables, by a number and description.

- Use a consistent referencing system to cite the source of all information presented in the management folio. Be aware that Web sites should have the date viewed included in the citation. Some examples of referencing books and web sites appear at the end of this unit. A simple referencing system involves you citing the **Author**, the **Date** of the publication, the **Title**, and the **Publisher** of the document with the publisher’s **Location**. Your school or local librarian can help you with this part of your work.
- Copying and pasting information from the Internet into the management folio simply demonstrates the skill of copying and pasting. This does not demonstrate the
skills of analysis and synthesis, and the ability to present an original piece of work. Copying other people’s work may have copyright implications which may bring fines or gaol terms. Make sure you gain copyright clearance before you use other peoples work, or at least acknowledge their work in your folio.

Activities

After reading the information contained on this unit of work and the links attached, attempt the activities set out below.

1. Using the guide set out in table 1, prepare a word processor template for your management folio.
2. Develop a Gantt chart for your project using the steps listed below:
   o List all the activities you think will be required to complete your major project.
   o Estimate the time you think each activity will take.
   o Consider the dependencies between each of the activities. That is, consider how activities are related. Which activities need to be completed before other activities may commence?
   o Complete an activity-time-dependency table.
   o Use this information and the steps set out in the first spreadsheet link to develop a basic Gantt chart for your major project, and then attempt to develop an enhanced Gantt chart using the steps set out in the second spreadsheet link.
3. Scan your annotated concept sketches from your weekly diary and then insert them into your management folio. Remember to identify these sketches in your folio.
4. Complete production drawings and 3D models of your project using a CAD package and then import these into your management folio. Remember to identify these drawings in your folio.
5. Review photographs you have taken of the construction phase of your major project. Select those photographs which you believe represent an accurate record of your work. Convert these to a digital format by scanning them (if necessary), edit them where necessary and then insert them into your management folio. Remember to identify these photographs in your folio.
6. As part of your major project research, investigate the availability of relevant database catalogues.
Section C – Workplace Communication

Literacy
- industry terminology
- written reports
- management folio
- computer software – word processing

Calculations
- ordering
- sizing
- quantities
- costing
- estimates

Graphics
- reading and interpretation
- freehand drawing and sketching
- working drawings
- computer software graphics
- signage
Industry terminology
Written reports

Written Reports are a specific ‘text type’ and as such will have certain characteristics. Written Reports will:

- Use formal language
- Use technical language related to the subject
- Usually be written in the present tense

How to make Writing an Industry Study Report Easy

This task of writing an Industry Study Report becomes easier if the student has a framework or scaffold to support the information presented. A Suitable framework for the report is described in the table following.

<table>
<thead>
<tr>
<th>1. Introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>• A statement explaining what the report is about</td>
</tr>
<tr>
<td>• It should include a short description of the subject</td>
</tr>
<tr>
<td>• Indicate to the audience the likely direction of the report</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Body of the Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>• A series of paragraphs about specific features of the subject.</td>
</tr>
<tr>
<td>• A list of suitable topics can be found in the syllabus on page 18 download the list</td>
</tr>
<tr>
<td>• Each paragraph may begin with a topic sentence that previews the remainder of the paragraph download a sample</td>
</tr>
<tr>
<td>• Following sentences provide more detail</td>
</tr>
<tr>
<td>• Each paragraph provides information on only one aspect of the report download a sample</td>
</tr>
<tr>
<td>• Technical language is used in any description show the sample</td>
</tr>
<tr>
<td>• Information and discussion is enhanced with pictures, graphs and tables where relevant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>• May summarise the report</td>
</tr>
<tr>
<td>• Can draw conclusions from the information provided</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. References</th>
</tr>
</thead>
<tbody>
<tr>
<td>• All reference material should be correctly acknowledged</td>
</tr>
<tr>
<td>• Approval for any photographs taken should be sought from appropriate people</td>
</tr>
</tbody>
</table>
Management folio

The Major Project

The Major Project contributes 60 per cent of the total examination mark and is marked at your school by a team of visiting Board of Studies markers. The marking scheme comprises:

1. Management Folio (Design and management and Workplace Communication) (20 per cent): This is your record of the design and management of your project according to the syllabus, including such areas as development of ideas, research, time plans, finance plans and ongoing evaluation.

   This documentation is your opportunity to communicate with the markers to explain how you made your project, the problems encountered and the solutions you achieved.

   Often the evidence of skills and techniques, such as intricate joint work, how you repaired an engine or how you constructed a web page, is hidden in your major project. The folio provides you with the opportunity to detail these skills and so convey to the markers valuable information.

   "Better folios used sophisticated CAD drawings, digital images and a variety of output devices to produce a quality of folio approaching professional desktop publishing." - a comment made in the 2007 Industrial Technology Notes from the Marking Centre

2. Production (40 per cent): The syllabus document lists the criteria used by the markers and these include: the quality of the product; evidence of a range of skills; links between planning and production; and evidence of solutions to problems in production.

   Ensure you present all of your jigs, templates and test pieces when you set up your major project for marking. They are all clear evidence of the testing and evaluation you have undertaken.
Introduction
The major project is the principle means of examining the outcomes of the HSC Industrial Technology course, including the content of the candidate’s identified focus area.

The major project is marked by the Board of Studies in term three of Year 12 for those students presenting for the HSC using the examination criteria provided in the Industrial technology syllabus.

The Process
Experienced markers are sent to all marking centres that have Industrial Technology candidates. At least two markers assess each major project separately. Specialist markers are sent to centres to mark each of the focus areas that are presented at any one centre.

Approximately twenty minutes is allocated to markers to assess each project but there is allowance for more time to be spent if warranted.

The major project has a mark value of 60 and this is broken down as follows:

- 20 marks for Design and Management/Workplace Communication
- 40 marks for Production of the major project.

Both the folio and the project are marked in conjunction with each other, to arrive at the final mark.

A marking checklist, based on the examination criteria, is used by examiners to ensure that all components of the criteria are marked for each candidate. An example of the marker check list used is shown in table 1.
Table 1: Example of a marking check list

<table>
<thead>
<tr>
<th>Major Project Marking Checklist</th>
<th>Marker Number</th>
<th>Group Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Candidate No.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Focus Area</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design and Management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statement of Intent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development of ideas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selection and justification of components, processes, and other resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timeline plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finance Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of appropriate industrial processes and equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evidence of safe working practices and OH&amp;S issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workplace Communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ongoing evaluation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appropriate design &amp;/or design modification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluation of the major project and its relation to the statement of intent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication Techniques</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer applications</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MARK / 20**

<table>
<thead>
<tr>
<th>Production</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of the product</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evidence of a range of skills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of Difficulty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Links between planning and production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evidence of industrial processes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of appropriate materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of industrial technologies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evidence of solutions to problems in production</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MARK /40**
Table 2 shows how a check list might appear for two student folios and projects from the one centre. The check list displays the following information:

1. Marker number and group number – marker information that is completed by the Board of Studies.
2. Candidate number – no names are used for privacy and security reasons.
3. Brief description of the project to distinguish projects that are similar in nature.
4. Focus area for the project.
5. Mark range. A five mark range for each criteria of the project that is to be assessed.

The mark ranges are different for Design and Management/Workplace Communication and Production.

Markers assess the range that best reflects the quality of the work done for each particular examination criteria. This is done separately for Design and Management/Workplace Communication and the Production of the product.

For Design and Management/Workplace Communication a tick is placed in the relevant box. After the boxes have been filled in for all the relevant headings, a single mark out of 20 is placed in the mark box below. This mark is derived from a line of best fit from the ticks entered in the boxes above. For example, a mark of 10 for Design and Management would represent a balance of the 13 criteria with some mark values above 10 and some below 10.

The same process is used to obtain a mark out of 40 for the Production of the major project.

6. Marking Criteria – These are taken directly from the Industrial Technology syllabus, under Major Project Examination Criteria on:
### Table 2: Example of a completed marking check list

**Major Project Marking Checklist**

<table>
<thead>
<tr>
<th>Candidate No.</th>
<th>xyzabcde</th>
<th>kfgyndlo</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>Jarrah wall un</td>
<td>Rad. Pine deal</td>
</tr>
<tr>
<td><strong>Focus Area</strong></td>
<td>TF</td>
<td>TF</td>
</tr>
<tr>
<td><strong>Design and Management</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statement of Intent</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Research</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Development of ideas</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Selection and justification of components, processes, and resources</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Timeline plan</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Finance Plan</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Use of appropriate industrial processes and equipment</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Evidence of safe working practices and OH&amp;S issues</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td><strong>Workplace Communication</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ongoing evaluation</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Appropriate design &amp;/or de-modification</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Evaluation of the major project and its relationship to the statement of intent</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Communication Techniques</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Computer applications</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td><strong>MARK / 20</strong></td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td><strong>Production</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality of the product</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Evidence of a range of skills</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Degree of Difficulty</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Links between planning and production</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Evidence of industrial processes</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Use of appropriate materials</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Use of industrial technologies</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Evidence of solutions to problems in production</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td><strong>MARK / 40</strong></td>
<td>18</td>
<td>30</td>
</tr>
</tbody>
</table>
**Table 3: Marking criteria for Design and Management/Workplace Communication**

Table 3 displays guidelines that would give students an indication of what is expected by the markers to gain marks in the range 17–20.

The criteria in the left-hand column are the major project examination criteria taken from the Board of Studies Industrial Technology syllabus (p. 47). Statements in the right-hand column are presented to give students some guidelines as to what is expected for students to gain marks in the range 17–20.

<table>
<thead>
<tr>
<th>Design and Management</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement of intent</td>
<td>Clarifies the intent of the major project by explaining clearly what is to be achieved and why.</td>
</tr>
<tr>
<td>Research</td>
<td>Describes a wide range of research conducted, which is relevant to the intent of the major project.</td>
</tr>
<tr>
<td>Development of ideas</td>
<td>Identifies components of the development and modification of major project design ideas, documenting judgements as appropriate.</td>
</tr>
<tr>
<td>Selection and justification of components, processes, and other resources</td>
<td>Justifies the selection of relevant materials, components, processes, including industrial processes and equipment, and other resources in the development of the major project.</td>
</tr>
<tr>
<td>Timeline plan – projected order of production and estimate of time allocation</td>
<td>Formulates a comprehensive and appropriate timeline.</td>
</tr>
<tr>
<td>Finance plan – projected cost of materials and services (if applicable)</td>
<td>Formulates a comprehensive and appropriate finance plan.</td>
</tr>
<tr>
<td>Use of industrial processes and equipment</td>
<td>Justifies the selection of appropriate materials, components, processes, including industrial processes and equipment, and other resources in the development of the major project.</td>
</tr>
<tr>
<td>Evidence of safe working practices and OHS issues</td>
<td>Shows the use of a wide range of appropriate safe working practices through examples of photographic or written evidence.</td>
</tr>
<tr>
<td><strong>Workplace Communication</strong></td>
<td>Description</td>
</tr>
<tr>
<td>Documentation of the major project from conception to completion including:</td>
<td>Description</td>
</tr>
<tr>
<td>Evidence of ongoing evaluation</td>
<td>Makes an in-depth judgement of the major project in relation to the statement of intent, during the planning and construction phases.</td>
</tr>
<tr>
<td>Appropriateness of design &amp;/or design modification</td>
<td>Assesses the relationship between the design, and modifications (if applicable), materials, components, and processes used in the development of the major project.</td>
</tr>
<tr>
<td>Students evaluation of the major project and its relationship to the statement of intent</td>
<td>Makes an in depth judgement of the major project in relation to the statement of intent, during the planning and construction phases.</td>
</tr>
<tr>
<td>Evidence of a range of communication techniques</td>
<td>Shows a wide range of communication techniques appropriate to the development of the major project.</td>
</tr>
<tr>
<td>Evidence of a range of computer applications, eg word processing, spreadsheets, CAD, multimedia</td>
<td>Shows a wide range of computer applications appropriate to the development of the major project.</td>
</tr>
</tbody>
</table>
Table 4: Marking criteria – Production of the major project

Table 4 displays guidelines that would give students an indication of what is expected to gain marks in the range 33–40. The criteria in the left-hand column are the major project examination criteria taken from the Board of Studies for production of the project. Statements in the right-hand column are presented to give students some guidelines as to what is expected for students to gain marks in the range 33–40.

<table>
<thead>
<tr>
<th>Production</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of the product</td>
<td>Demonstrates very high quality in all aspects of the major project production.</td>
</tr>
<tr>
<td>Evidence of a range of skills</td>
<td>A highly demanding project, with evidence of high quality in the application of a wide range of skills and techniques used in the planning and production of the major project.</td>
</tr>
<tr>
<td>Degree of difficulty</td>
<td>A highly demanding project, with evidence of high quality in the application of a wide range of skills and techniques to solving problems in the planning and production of the major project.</td>
</tr>
<tr>
<td>Links between planning and production</td>
<td>Completed project relates closely to what was intended. Close links between actual construction processes, management and thorough research and planning are evident and clearly articulated.</td>
</tr>
<tr>
<td>Evidence of industrial processes</td>
<td>Shows and describes the use of a wide range of appropriate industrial processes and materials in the production of the major project.</td>
</tr>
<tr>
<td>Use of appropriate materials</td>
<td>Shows and describes the use of a wide range of appropriate industrial processes and materials in the production of the major project.</td>
</tr>
<tr>
<td>Use of industrial technologies</td>
<td>Uses and documents a range of appropriate industrial technologies in the production of the major project.</td>
</tr>
<tr>
<td>Evidence of solutions to problems in production</td>
<td>Shows how solutions to problems in major project production were addressed and accurately determines their value.</td>
</tr>
</tbody>
</table>
Table 5: Major project folio
When preparing the major project folio, students need to document information that relates to the design, management and production of their major project. Table 5 displays some guidelines based on the examination criteria for the preparation of their major project folio.

<table>
<thead>
<tr>
<th>Design and Management</th>
<th>Guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement of intent</td>
<td>The statement of intent should be a clear explanation of what is to be constructed as the major project. The explanation should name what is to be made and the reasons why it is to be made.</td>
</tr>
<tr>
<td>Research</td>
<td>There should be a large range of research directly related to the construction of the major project. Research can be in the form of: internet, similar projects / ideas, books, brochures, etc. Literature that has no direct reference to the major project does not gain the student any marks. Where appropriate students need to research each different part of their project.</td>
</tr>
<tr>
<td>Development of Ideas</td>
<td>Student ideas need to be put down on paper. In many projects the development of ideas is very disjointed and does not flow in a logical sequence. Markers look to see there is an appropriate sequence of ideas relevant to the project. These ideas should explain how the major project is to be thought out and constructed.</td>
</tr>
<tr>
<td>Selection and justification of components, processes, and other resources</td>
<td>Where appropriate, for each different part of the project the student needs to look at the options available and justify why they have chosen to make their project the way they have, e.g. joints, type of material, size of material, finishes.</td>
</tr>
<tr>
<td>Timeline plan – projected order of production and estimate of time allocation</td>
<td>A plan of what is to be finished by a certain date should be completed before the major project is commenced. This is generally done in a table either weekly, monthly or by school term. Another column in the table should be used as an actual account of when the work was completed. This column is therefore done progressively and compared to expected date of completion.</td>
</tr>
<tr>
<td>Finance plan – projected cost of materials and services (if applicable)</td>
<td>Markers look for evidence of preplanning the costing of projects. Students should investigate costs before they start the major project to see if they can afford it. They should also list the individual item costs in a table or similar format. As the components are purchased their accumulating cost should be compared to the original projected cost. The date the components are purchased should also be included.</td>
</tr>
<tr>
<td>Use of industrial processes and equipment</td>
<td>There is generally more than one way for students to produce different parts of their project. Has the most appropriate industrial processes and equipment been used by the student? Written documentation should reinforce the reasoning for the industrial processes and equipment used.</td>
</tr>
<tr>
<td>Evidence of safe working practices and OHS issues</td>
<td>Photographic evidence should highlight safe working practices such as eye, hearing and breathing protection when working on their major project. Photographic evidence showing unsafe practices should not be included. Written evidence should also be included on any aspect relevant to their major project, i.e. machines or tools used.</td>
</tr>
<tr>
<td><strong>Workplace Communication</strong></td>
<td>Documentation of the major project from conception to completion including:</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Evidence of ongoing evaluation</strong></td>
<td>The major project should be evaluated and recorded on a continual basis during its construction. The evaluation should highlight both the good points and the bad points. Markers do not penalise students for recording negative comments about what they have constructed but students should explain how they could have avoided or fixed problems.</td>
</tr>
<tr>
<td><strong>Appropriateness of design and/or design modification</strong></td>
<td>From the written documentation and the major project markers assess whether the design is appropriate for the project. Does the project do what the statement of intent says it will do? Very few projects are made without modifications. As the project is continually assessed, it is logical to assume modifications will be continually made during the manufacture of the major project. These modifications need to be documented with valid reasons as to why changes have been made.</td>
</tr>
<tr>
<td><strong>Students evaluation of the major project and its relationship to the statement of intent</strong></td>
<td>Students should evaluate the finished major project against the statement of intent. The evaluation should note any differences and explain why. As well as if any part or parts of the construction process could be improved or done differently. Markers do not penalise students for negative comments.</td>
</tr>
<tr>
<td><strong>Evidence of a range of communication techniques</strong></td>
<td>Students should show as many different communication techniques as possible during the construction of their major project. This could include internet research, photos, word processing, spreadsheet, CAD drawing, freehand pencil drawing, use of computer where appropriate (screen display), video, set up to demonstrate project, display board.</td>
</tr>
<tr>
<td><strong>Evidence of a range of computer applications, e.g. word processing, spreadsheets, CAD, multimedia</strong></td>
<td>Students should show as many computer applications as possible appropriate to their major project. As a minimum, students should have evidence of word processing, use of graphics, spreadsheets and CAD drawings.</td>
</tr>
</tbody>
</table>
**Major Project - Examiners Comments**

The major projects presented in most focus areas showed an increase in both quality and design. Folios have steadily increased in both the level of presentation and the amount of research and planning undertaken by candidates.

Better folios were presented in a logical and carefully laid out manner, where the content was easily identifiable.

A broader range of information and communication technology (ICT) skills were apparent in their preparation.

**Design and Management**

Many candidates seemed very capable of producing a quality product, but devoted a disproportionate amount of time and effort to the accompanying folio. Teachers need to highlight the importance of this folio in the marking of the project and its role in the marking process. The major projects, particularly in Multimedia Industries, are shown in their completed form.

Much time and effort, as well as a substantial amount of skill, has been utilised in applying the many different processes involved in the development of these projects. From outside appearances much of this is not apparent in the project itself and it is **only through the folio that the examiners are able to understand the full input** of the candidate.

Candidates should be aware of the marking criteria, available from the Board’s website, and be familiar with these criteria and be able to apply them to their projects

**Research and information gathering** should be relevant to the project as detailed in the statement of intent. Brochures, catalogues, company information and downloads from web pages must relate to the project being constructed, and the candidate must interact with the information in some way. This should be clearly evident. Some candidates, particularly in Graphics Industries, collect great quantities of brochures, especially from project home companies. These are often included as research, but many show little evidence of being used as a basis for the project, being just lumped together in a folio with little, if any, annotations. Better responses showed clearly what information had been gained and how it would be used with the project. They also included a brief, to the point evaluation of the research for each item, process or material, as part of on-going evaluation. This can be presented in a number of ways, eg a PMI analysis.

**Timelines and finance plans** were usually well presented and in an increasing variety of ways. Most candidates were able to divide their time and allocate processes to it. Candidates need to be sure to add detail in these plans and not restrict them to a few general headings. Research, for example, needs to include details of type, how and/or where. It is also important to note that these time and finance plans must include both a proposed plan and an actual plan and not be written after the event.

Most candidates were able to comment in some detail regarding the personal protective equipment (PPE) aspects of OHS, especially when using machinery in the workshop. Few candidates outlined the OHS concerns associated with the safe handling of materials, both the physical handling and the chemical/dust concerns, not just PPE for machine use and the safe handling of tools, etc.
Communication

In most instances, candidates successfully used a variety of communication techniques to complete the Design, Management and Communication (DMC) folio.

Better folios used sophisticated CAD drawings, digital images and a variety of output devices to produce a quality of folio approaching professional desktop publishing. Very few candidates completed the folio with no ICT skills being apparent, even the weakest folios contained evidence of word-processing and spreadsheets.

Sketching of ideas and their development was not particularly strong, with some exceptions. Most candidates included some rough, and in some cases, almost unidentifiable sketches without any annotation. Candidates must remember that this section of the folio communicates to the examiner how they arrived at their final design, or how an original design was modified. All of their sketches should be included and they must be clearly annotated.

Production

Most candidates were able to satisfactorily manage their time and resources to produce a finished project, albeit of varying quality. The quality of the major projects continues to improve.

Projects should also be of sufficient rigour to allow the candidate to fully satisfy the marking criteria for the major project.

Weaker Multimedia Industries responses contained downloaded material from sources found on the internet. This is not a recommended practice and should be discouraged. As is the case with all focus areas, any work that is not the work of the candidate should be acknowledged as such. Markers recognise the different standard of the downloaded material compared to a candidate’s own work.

Candidates should present as much supporting material as possible with their projects. Jigs, models, prototypes, preliminary sketches, working rods and all other material used during construction identifies a broader range of skills and techniques that may have otherwise been overlooked.

Multimedia Industries candidates be aware that it is their own responsibility to ensure that their project is fully operational at the time of marking.

Many candidates used some degree of outside help and/or resources. Care must be taken to fully document these outside resources in the folio. Candidates will not be given credit for work done by others.

Often, Multimedia Industries responses did not fully show how their projects evolved. They need to present the development of the project and not just the final product. In most cases, responses showed little evidence of storyboarding, sketching or planning. Better responses used screen dumps, dated and initialled by their teachers at regular intervals to give a clear indication of project development. These better responses also used a range of processes that included video, digital imaging and web design.
Industrial Technology

Workplace Communication

Management Folio

This unit of work addresses aspects of the following syllabus outcomes:

H5.1: selects and uses communication and information processing skills

H5.2: selects and applies appropriate documentation techniques to project management


Folio Guides:

i Preliminary

ii HSC
Preliminary

How to format the Minor Project Folios

- The folio is written and graphic (= drawing and/or pictorial) evidence showing all aspects of the design, construction and evaluation of the minor practical projects.

- For the minor projects in the Preliminary Year it is advisable to organise your folio in the same sequence in which the major project folio in Year 12 is done but, of course, make it much simpler and shorter than your final major project folio.

- It is a requirement of the course that students use word processing software so it is a good idea to use a word processor for both minor and major project folios and aim to make your presentation neat, creative and user friendly.

- The following headings are identical to those used for the major work folio so that you will become familiar with the terminology. For an explanation of the various headings refer to the pages indicated after each heading.

- Use the boxes provided after each heading to tick off when you have finished each part.
Suggested Set-out for the Minor (Preliminary) Project Folios:

**DESIGN**  
(major heading on title page)

(i) **Statement of Intent**  
    Minor heading, new page

(ii) **Research**  
    Minor heading, new page

(iii) **Development of Concepts & Ideas**  
    Minor heading, new page

(iv) **Selection & Justification of Materials, Components, Processes & Other Resources**  
    Minor heading, new page

**MANAGEMENT**  
(major heading on title page)

(i) **Timeline**  
    Minor heading, new page

(ii) **Finance Plan**  
    Minor heading, new page

(iii) **Use of Appropriate Industrial Processes & Equipment**  
    Minor heading, new page

(iv) **Evidence of Safe Working Practices & OH & S Issues**  
    Minor heading, new page
WORKPLACE COMMUNICATION

(i) Workshop Drawings
   Minor heading, new page

(ii) Record of Procedures
    Minor heading, new page

(iii) Sketches
     Minor heading, new page

(iv) Calculations
     Minor heading, new page

PROJECT EVALUATION

(i) Evidence of Ongoing Evaluation
    Minor heading, new page

(ii) Appropriateness of Design and/or Design Modification
     Minor heading, new page

(iii) Student's Evaluation of the Major Project and its Relationship to Statement of Intent
     Minor heading, new page
Suggested Set-out for the Major (HSC) Project Folios:

The first question often asked is “how big should it be?”. There is no prescribed answer for this – the folio needs to be big enough to thoroughly cover all of the point outlined below.

It is highly advisable to document every stage of project – from early ideas right through to publication. Use lots of screen dumps, photos, scanned images, prototypes – space them out and explain what they are and where they fit in.

If you change your mind about anything - that's fine, but document it – say why you changed your mind, what you will do differently and how this will improve your project.

Don’t try to ‘squeeze’ up your folio to save paper – space it out well and use plenty of white space – format text so that paragraphs have 6pt spacing – print on one side of the paper only – all of this may mean few more pages are used, but it will enhance the final presentation.

The following guide suggests where you should have Title pages (effectively new chapters) – try to design different page in keeping with the theme of your project. It can also be quite effective to use a graphic header in your folio: keep it consistent with the theme of your project, even incorporating a logo that may have been used in the project.

It is not inappropriate for large folios to be presented in more than one booklet – a very large folio could be approaching 300 pages, and presented as three booklets.

Perhaps you could include a Table of Contents – it may assist in finding specific content of your folio.

Remember how much the folio is worth:

- **HSC examination** 40%
- **Project production** 40%
- **Folio** 20% - this attainable when you:
  - start your folio immediately and keep an up-to-date record of everything you do
  - adhere to the structure that is set out below
  - are familiar with, and follow the marking guidelines as specified by the BOS (set out previously).
(i) **Statement of Intent**

*Minor heading, new page*

The Sol should:

Explain exactly what the project is

- State the motivation for and purpose of the the project
  - Why you have decided on this particular project
  - Who will use it, and what it will be used for

- Specify the parameters (limits) if any (physical, economic, technical)

- State the goals you expect to achieve, ie, use it at home, sell it, market it

- Explore further possibilities

(ii) **Research**

*Minor heading, new page*

Document all research done:

- Books, magazines, internet sites
- Previous designs and solutions
- Experiment and testing. This may include techniques with a particular software package and applying test data

Remember, this section is evidence of research, not a place where you print out your research.

(iii) **Development of Concepts & Ideas**

*Minor heading, new page*

- Use the process of ideation as described in “The Design Process” to obtain good ideas.
- Compile a list of ideas you came up with when research your design – labelled sketches, a list of written ideas, or diary entries
- It is important to show the evolution of your design solutions – ensure all sketches are well labelled & easily understood
Here you are required to present logical reasons why you have chosen materials, components and processes.

- Materials used in the final production
- Components of the package
- Processes – hardware and software

You must provide options in each category before you can justify a choice.

Justification must be given for your choices, and these reasons are to be based on documented research / experimentation (previously documented)

Use a table like below to set this section out

<table>
<thead>
<tr>
<th>OPTIONS</th>
<th>CHOICE</th>
<th>JUSTIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Materials</strong></td>
<td><strong>List chosen option</strong></td>
<td>Justify your choice based on the documented research</td>
</tr>
<tr>
<td>- Option A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Option B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Option C</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Components</strong></td>
<td><strong>List chosen option</strong></td>
<td>Justify your choice based on the documented research</td>
</tr>
<tr>
<td>- Option A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Option B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Option C</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Processes</strong></td>
<td><strong>List chosen option</strong></td>
<td>Justify your choice based on the documented research</td>
</tr>
<tr>
<td>- Hardware</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Option A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Option B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Option C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Software</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Option A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Option B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Option C</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other Resources</strong></td>
<td><strong>List chosen option</strong></td>
<td>Justify your choice based on the documented research</td>
</tr>
<tr>
<td>- Option A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Option B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Option C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(iii) Timeline

Minor heading, new page

- A gantt chart should be used as evidence of advanced planning. The chart may be created simply using spreadsheet software, or the more advanced (and appropriate) MS Project.
- The plan (chart) must show the action, estimated and actual time of completion of action and any variation of the planned sequence.

(iv) Finance Plan

Minor heading, new page

- Multimedia projects do not usually involve a great deal of costs, particularly if you consider that you won’t be going out and buying hardware and software to use for your work. The value of the equipment you are using should however be taken into account (notional cost).
- The following information should be included:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>EXPECTED / NOTIONAL COST</th>
<th>ACTUAL COST</th>
<th>DATE OF PURCHASE</th>
<th>BALANCE</th>
</tr>
</thead>
</table>

- Use a spreadsheet to create your finance plan – it may be simple, but it is evidence of more skills.

(iii) Use of Appropriate Industrial Processes & Equipment

Minor heading, new page

- Make a list of all industrial processes and equipment you have used in the production of your project. This will include both hardware and software – not all of either could be considered Industry Standard.
- In documenting your IP&E you should explain how appropriate they were compared to non-IP&E options.

(iv) Evidence of Safe Working Practices & OH & S Issues

Minor heading, new page

- Photographic and written evidence
- Relate practices to any relevant OH&S regulation
Here you must demonstrate a range of communication techniques you have used in the project and folio from concept to completion. These include calculations, graphics, reports (folio), audio visual, recorded interviews, email, internet etc.

Direct the examiner to these aspects of your folio & project to reinforce the fact that you have covered this area of the Major Project Criteria.

(v) Workshop Drawings

- concept maps
- context diagrams
- storyboarding

(vi) Record of Procedures

This section of the folio is aimed at showing how the project is planned and constructed. Best done using photographs/screen dumps which are arranged in the correct planning and construction sequence with a step by step explanation of each. This may mean your folio could become quite voluminous (if done thoroughly).

It is advisable to do this as well as a diary and gantt chart

Make sure each photograph/screen dump is clearly labelled and explained.

(vii) Sketches

These are generally well labelled freehand sketches of your thoughts and design ideas.

Sketches should be digitised (scanned) and embedded into your folio where appropriate

(viii) Calculations

Include all calculations:
- File size calculations – relate this to the use and storage media – eg, internet, CD vs DVD
- Cost of all components, including printing
- Use spreadsheet
a) Evidence of Ongoing Evaluation

You must show clear evaluation of systems, processes and decisions throughout the Major project.

To do this make a table (in this section) of all the dates on which you made an evaluation on materials, designs, procedures etc during the project.

b) Appropriateness of Design and/or Design Modification

Give reasons why your final design and/or design modification is appropriate for the intended purpose of the project include positive and negatives.

If any part of the original design was inappropriate, explain any modifications which were necessary/desirable at any time during the project.

Give reasons why these modifications were necessary.

Document all modifications.

c) Student's Evaluation of the Major Project and its Relationship to Statement of Intent

Here you must explain whether your finished project achieves the goals set out in your Statement of Intent.

Evaluate each goal from your Statement of Intent in the same order in which they were presented at the beginning of your folio.

Include negatives as well as positives with a full explanation.
Although not specifically required for the folio, it is advisable to include the following as folio headings:

**Quality of Product**
*Minor heading, new page*

Students should always aim to achieve a top quality product – commercial quality?
Quality should relate to all aspects of the design, planning, management, production and evaluation process.
You are advised to use quality materials – it is very important to produce an excellent finish to all aspects of your project.

**Evidence of a range of Skills**
*Minor heading, new page*

Briefly explain the range of technical skills used in your project
Include here the techniques & skills you used to overcome problems encountered
Explain any hidden complexities which may be easily overlooked by the examiner

**Degree of Difficulty**
*Minor heading, new page*

The markers will want to see evidence of a project which has a degree of difficulty appropriate to a Year 12 project.
Relate the processes and/or technologies used to other available processes/technologies and compare such aspects as time, quality, skills developed, cost.
Direct the examiner’s attention to any aspects that you or your teacher consider to of significant difficulty.

**Links between Planning and Production**
*Minor heading, new page*

Here you must demonstrate that your design, planning and management have been used for the production of your project.
Direct the examiner’s attention to those areas to those areas that were essential for the production of your production.
Evidence of Industrial processes
Minor heading, new page

Direct the examiner’s attention to any parts of the project which have been done by processes as used in the industry

Use of Appropriate Materials
Minor heading, new page

Having previously justified your selection of materials, now direct the examiner’s attention to how good your choice has been in the finished project.

Use of Industrial Technologies
Minor heading, new page

Direct the examiner’s attention to the parts of the project that have been done by the use of industry standard technologies – this will in particular refer to hardware and software.

Evidence of Problem Solving
Minor heading, new page

This is a means of communicating what practical problem solving took place during design and construction

Direct the examiner’s attention to where solutions to problems discovered during design and construction of the project – not merely explaining how mistakes were fixed.
Computer software – word processing your folio

It is a requirement that your folio be a word processed document. It would hardly seem necessary to state this, but ... The marking guidelines indicate that the examiners are looking for “Evidence of a range of computer applications, eg word processing, spreadsheets, CAD, multimedia”. Here is your opportunity to ‘show off’ a wide range of skills. The table below suggests a few.

<table>
<thead>
<tr>
<th>Word Processing Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Spell &amp; grammar check</td>
</tr>
<tr>
<td>• Layout consistency</td>
</tr>
<tr>
<td>• Text alignment</td>
</tr>
<tr>
<td>• Typeface &amp; font management</td>
</tr>
<tr>
<td>• Paragraph and line formatting</td>
</tr>
<tr>
<td>• Use of Tabs</td>
</tr>
<tr>
<td>• Inserting:</td>
</tr>
<tr>
<td>▪ Header &amp; footer</td>
</tr>
<tr>
<td>▪ Page number</td>
</tr>
<tr>
<td>▪ Graphics from a variety of sources:</td>
</tr>
<tr>
<td>o Digital camera</td>
</tr>
<tr>
<td>o Scanner</td>
</tr>
<tr>
<td>o Spreadsheet tables &amp; charts</td>
</tr>
<tr>
<td>o Screen dumps</td>
</tr>
<tr>
<td>o 2D &amp; 3D Graphics applications</td>
</tr>
<tr>
<td>o Word diagrams</td>
</tr>
<tr>
<td>▪ References:</td>
</tr>
<tr>
<td>o Table of contents</td>
</tr>
<tr>
<td>o Captions</td>
</tr>
<tr>
<td>o Footnote</td>
</tr>
<tr>
<td>▪ Tables</td>
</tr>
<tr>
<td>▪ Bullets and numbering</td>
</tr>
</tbody>
</table>
Calculations

- ordering
- sizing
- quantities
- costing
- estimates

Use a spreadsheet to do this – include a screen dump that shows the formula as well

Calculations – Costing a multimedia project.

The general budgetary calculations given in the initial part of this unit are a generic guideline for a year 12 project. This unit is designed to help students cover costing and calculations requirements for the Industrial Technology syllabus in the Multimedia focus area.

Identifying memory requirements - Storage of data – file sizes

Being a student in multimedia, you are aware that computer data is stored in memory and read by the CPU as bits.

Each bit has a value of either 0 or 1.

Even a simple file contains a large number of bits, so file size is more conveniently referred to in bytes, kilobytes, megabytes or gigabytes.

<table>
<thead>
<tr>
<th>Units</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 byte</td>
<td>$2^3$ bits</td>
<td>8 bits</td>
<td></td>
</tr>
<tr>
<td>1 kilobyte</td>
<td>210 bytes</td>
<td>1 024 bytes</td>
<td>8 192 bits</td>
</tr>
<tr>
<td>1 megabyte</td>
<td>220 bytes</td>
<td>1 048 576 bytes</td>
<td>8 388 608 bits</td>
</tr>
<tr>
<td>1 gigabyte</td>
<td>230 bytes</td>
<td>1 073 741 824 bytes</td>
<td>8 589 934 592 bits</td>
</tr>
</tbody>
</table>

Identifying memory requirement - images - pixels

Pictures or images that are digitised for use in multimedia are converted to a number of discrete picture elements. Picture elements is abbreviated to construct the term 'pixel'.

Each pixel has a defined colour/tone and location in the page.

The file size and download speed of a multimedia page are affected by the number of colours used (termed bit depth) and the number of pixels used to display information.

Computers commonly display information at 72 dots per inch (dpi) or 72 pixels.

Digital photographs on photographic paper require about 300 dpi to allow good quality reproduction.
The number of pixels per inch used to display graphics on a multimedia page is set by the programmer.

It is worth noting that as the number of pixels used to display an image increases, the amount of information required by the user to download (file size/bandwidth) also increases. If an image is too large to download easily, it can be cumbersome and irritating for the end user of the multimedia page to use.

**Activity 1**

Given that 1 inch = 2.54cm, calculate the number of pixels present in a picture of 6cm high by 10cm wide at 72 dpi.

**Activity 2**

Using similar methods to those you used above, what is the number of pixels used to create a picture 6cm high by 10cm wide at 300 dpi.

**Activity 3**

A computer monitor is set to display 800 by 600 pixels. Calculate the total number of pixels that need to be controlled by the CPU.

**Activity 4**

A computer monitor is set to display 1024 by 768 pixels. Calculate the total number of pixels that need to be controlled by the CPU.

**Activity 5**

Complete the following table:

<table>
<thead>
<tr>
<th>Resolution (dpi)</th>
<th>Suitable for which application?</th>
</tr>
</thead>
<tbody>
<tr>
<td>72 dpi</td>
<td></td>
</tr>
<tr>
<td>150 dpi</td>
<td></td>
</tr>
<tr>
<td>300 dpi</td>
<td></td>
</tr>
</tbody>
</table>
Bit depth

Bit depth is an indication of the number of colours present in the image.

A bit depth of 1 allows 2 discrete colours to be made available to show an image. 
A bit depth of 2 allows $2^2 = 4$ discrete colours to be made available 
A bit depth of 4 allows $2^4 = 16$ discrete colours to be made available 
A bit depth of 8 allows $2^8 = 256$ discrete colours to be made available 
A bit depth of 16 allows $2^{16} = 65,536$ discrete colours to be made available 
A bit depth of 24 allows $2^{24} = 16,777,216$ discrete colours to be made available.

In the Microsoft Windows system, a bit depth of 16 (65,536 colours) is termed “High Colour,” while a bit depth of 24 is termed “True Colour” (16,777,216 colours).

VGA systems work at a bit depth of 8 (256 colours).
It is worth noting the relationship between file size and bit depth.

The file is displayed in the table below at a range of colour depths.

<table>
<thead>
<tr>
<th>Bit Depth</th>
<th>File size as a bitmap (*.bmp)</th>
<th>File size as a JPEG (*.jpeg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note that file size is set to a constant $1607 \times 784$ pixels</td>
<td>3694 kb</td>
<td>229 kb</td>
</tr>
<tr>
<td>Bit depth of 24 (millions of colours)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bit depth of 24 (set to give 65 536 colours)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3694 kb                        | 229 kb

Paint Shop Pro 8
The number of unique colours used in this image is 16772.

Page 114
<table>
<thead>
<tr>
<th>Bit depth</th>
<th>32 768 colours</th>
<th>234 kb</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>3694 kb</td>
<td>234 kb</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bit depth</th>
<th>256 colours</th>
<th>307 kb</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1233 kb</td>
<td>307 kb</td>
</tr>
<tr>
<td>Bit depth of 8 (greyscale – 256 shades)</td>
<td>1233 kb</td>
<td>191 kb</td>
</tr>
<tr>
<td>Bit depth of 4 (16 colours)</td>
<td>616 kb</td>
<td>247 kb</td>
</tr>
</tbody>
</table>
The relationship between file size and colour depth for the above images is shown in the table above and summarised in the screenshot below:

<table>
<thead>
<tr>
<th>Name</th>
<th>Size</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>other images, details etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>elephants 16 colours.bmp</td>
<td>157 KB</td>
<td>1607 x 764</td>
</tr>
<tr>
<td>elephants 4bit 16 colours.bmp</td>
<td>616 KB</td>
<td>1607 x 764</td>
</tr>
<tr>
<td>elephants 8bit 256 colours.bmp</td>
<td>1,233 KB</td>
<td>1607 x 764</td>
</tr>
<tr>
<td>elephants 8bit greyscale 256 shades.bmp</td>
<td>1,233 KB</td>
<td>1607 x 764</td>
</tr>
<tr>
<td>elephants 24bit 16 million colours.bmp</td>
<td>3,694 KB</td>
<td>1607 x 764</td>
</tr>
<tr>
<td>elephants 24bit 32 thousand colours.bmp</td>
<td>3,694 KB</td>
<td>1607 x 764</td>
</tr>
<tr>
<td>elephants 24bit 64 thousand colours.bmp</td>
<td>3,694 KB</td>
<td>1607 x 764</td>
</tr>
<tr>
<td>elephants 8bit 2 colours.bmp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>elephants 8bit 256 colours.bmp</td>
<td>307 KB</td>
<td>1607 x 764</td>
</tr>
<tr>
<td>elephants 24bit 16 million colours.bmp</td>
<td>221 KB</td>
<td>1607 x 764</td>
</tr>
<tr>
<td>elephants 24bit 32 thousand colours.bmp</td>
<td>224 KB</td>
<td>1607 x 764</td>
</tr>
<tr>
<td>elephants 24bit 64 thousand colours.bmp</td>
<td>229 KB</td>
<td>1607 x 764</td>
</tr>
<tr>
<td>elephants greyscale 256 shades.bmp</td>
<td>191 KB</td>
<td>1607 x 764</td>
</tr>
</tbody>
</table>

By way of explanation, the reason for the JPEG files all being similarly sized is that JPEG, by definition, stores all pictures at a mandatory 24 bit colour depth.

GIF files are saved at a mandatory colour depth of 8 bit (256 colours) so, for simple graphics containing a few areas of uniform colour, are preferred for multimedia applications as they are much smaller than the equivalent JPEG.
Image storage requirements – bit depth

Before the size of an image file can be calculated, it is prudent to ensure that you are using the best type of file compression/file format for the image.

<table>
<thead>
<tr>
<th>Format</th>
<th>Bit depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>bitmap</td>
<td>As per original image</td>
</tr>
<tr>
<td>GIF</td>
<td>8 bit (256 colours)</td>
</tr>
<tr>
<td>JPEG</td>
<td>24 bit (16 million colours)</td>
</tr>
<tr>
<td>PNG</td>
<td>8 bit or 24 bit (16 million colours)</td>
</tr>
</tbody>
</table>

Activity 6

Complete the following table

<table>
<thead>
<tr>
<th>Extension/file type</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPEG</td>
<td></td>
</tr>
<tr>
<td>PNG</td>
<td></td>
</tr>
<tr>
<td>GIF</td>
<td></td>
</tr>
<tr>
<td>BMP</td>
<td></td>
</tr>
<tr>
<td>SVG</td>
<td></td>
</tr>
</tbody>
</table>

Note that the bitmap images are saved at (an uncompressed) full size while the JPEG images are saved as a compressed (lossy) file. The advantages of using JPEG file compression for storing images is clearly evident when you look at the difference in file size when it is saved (note that the file size when it is in use is the uncompressed file size, identical to the equivalent bitmap file size.) The example above clearly demonstrates the benefits of storing photographs for multimedia presentations in the JPEG format (smaller file size needed for storage and transmission.)

Note that the JPEG and the bitmap require the same amount of computer memory when they are being displayed. The JPEG compression format (as well as any other compression format such as PNG, GIF, or SVG) means that the size of the file when it is saved is far smaller than the raw image file size. BMP format is saved as the raw image file, and these files are unnecessarily large for use as part of a multimedia presentation.
Image processing – raw image file size and bit depth.

The amount of computer memory (video memory/RAM) needed to display a raw image at 1607 x 784 pixels at a colour depth of 24 bits per pixel is clearly the same, regardless of file format, as the monitor has to display an identical image (equal to the number of pixels times the bit depth.)

As can be inferred from the above example, bitmaps are saved in the raw image format and are a large file size unsuited to use in multimedia presentations and websites.

For example, consider the 1 bit colour depth picture shown above (bitmap file size 157 kB). The raw image file size = (1607 x 784 x 1) ÷ 8 = 157486 Bytes = 157486/1024 = 154 kB (the difference between the two file sizes is due to other minor data saved with the file as well.)

Activity 7

Calculate the raw image file size required for an image of size 1607 x 784 pixels at a colour depth of 24 bits

Processing Requirements

The size of an image (dpi as well as bit depth) affects the processing requirements.

The amount of memory required to display a full-sized image on a screen at a smallest screen resolution is significant.

This document is being written on a laptop with a screen size of 1024 by 768 pixels at a colour depth of 32 bits (24 bit colour plus 8 bits for transfer of transparency data)

(1024 x 768 pixels, bit depth of 32 = 16 million colours) = 1024 x 768 x 32/8 = 3145728 B = 3.00 MB

Activity 8

Calculate the amount of memory required to display all data on your computer screen. If you are unsure of your screen settings, click here http://www.webdoodles.org/pages/screentest.htm}
The impact of using over-sized images onto the system RAM/graphics memory.

Assume that two photographic quality images (150 mm wide by 100 mm × 300 dpi/24 bit colour depth) are accidentally included in a webpage by the webpage designer.

The width of this image is 1800 pixels (= 150 mm by 300dpi) which is wider than the screen. The central processing unit will have to store the complete image in its memory and then resize the images to fit onto the screen.

The memory requirement to display this webpage is now therefore:

1. the amount of memory devoted to display of the webpage – 3.00MB as above, plus;
2. the amount of memory required to store the two over-sized images (1800 × 1200 pixels at 24 bit colour depth) in memory to allow their resizing for display.

\[ 2 \times (1800 \times 1200 \times 24)/8 = 12960000 \text{ Bytes} \]

\[ = 12.36 \text{ MB} \]

Therefore, the total memory requirement just to display this webpage is 15.36 MB. This is very close to the 16MB graphics co-processor that a lot of smaller/cheaper computers use and is therefore likely to cause problems with display and excessive bandwidth (on a 56kbits/second dialup modem, this page would also take about 90 minutes to download.)

Identifying memory requirement - video.

Firstly, some background information:

You will be aware that video is created by overlapping images and embedding sound in the file.

The size of a raw video file that is stored in the computer memory for display is dependent upon the following:

- Frame rate/refresh rate (number of frames per second being displayed)
- Number of pixels (horizontal times vertical.)
- Bit depth (bits per pixel)

<table>
<thead>
<tr>
<th>Frame rate (refresh rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 frames/sec NTSC standard, refresh rate of computer monitors, standard MPEG frame rate.</td>
</tr>
<tr>
<td>25 frames/sec PAL PAL standard (UK)</td>
</tr>
<tr>
<td>24 frames/sec Traditional frame rate of motion pictures</td>
</tr>
<tr>
<td>12-15 frames/sec Common frame rate for animation</td>
</tr>
<tr>
<td>8 frames/sec Minimum frame rate for animation, commonly used in animated GIFs</td>
</tr>
</tbody>
</table>

Common video specified file sizes include 720 × 480 pixels (= 16:9 NTSC aspect ratio) or 720 × 576 pixels (= 4:3 PAL aspect ratio)
[ IMAGE COMPONENT ]

Raw video file size = \[
\frac{\text{Frame rate} \times \text{Time (sec)} \times \text{Number of pixels in image} (\text{pixel height times width}) \times \text{bit depth}}{8 (\text{= conversion of bits to bytes})}
\]

PLUS

[ AUDIO COMPONENT ]

Raw audio file size = \[
\frac{\text{Sampling rate} \times \text{Time (sec)} \times \text{bit depth} \times \text{No. channels}}{8 (\text{= conversion of bits to bytes})}
\]

EQUALS RAW MOVIE FILE SIZE

Eg: a 30 frame/sec video that runs for 120 seconds at a frame size of 720 x 480 pixels at a bit depth of 24/pixel has a raw video file size (excluding audio file size) of:

Raw video file size = \[
\frac{(30 \times 120 \times 720 \times 480 \times 24)}{8} = 3559 \text{ MB} = 3.6 \text{ GB}
\]

There are many common formats for video display. The most common, other than MPEG, used in multimedia authoring include Windows Media Player (*.wmv), Flash Player (*.flv, *.swf), Real Player (*.ram), DivX Player (*.divx, *.dmf), QuickTime (*.mov) and an older standard that is still used, Audio Video Interleave (*.avi).

Each of these file formats have advantages, predominantly in compression or ability to maintain image quality while sustaining significant file compression. There are some details of these file formats here [http://www.planetoftunes.com/computer/mediaplayers.html](http://www.planetoftunes.com/computer/mediaplayers.html)

The MPEG compression codec has achieved some of the most notable compression between the raw video file size and the file size saved to disk. It achieves this because it transfers data in packets, and only saves detail of changed areas between each frame. If a portion of the frame remains unchanged, it is noted and therefore redundant data is not saved.
Streaming and bitrate

When creating material to be downloaded through a modem it is recommended that you allow for the impact on the person receiving the information on the bandwidth.

A dial up modem of 56 kbps allows 56 thousand bits of data to be transferred at a maximum rate per second, however, these connections typically function at a far lower rate, say 28kbps. The further you are away from the telephone exchange, the higher the error rate and the slower the transmission rate.

28 thousand bits per second = 28000/8 = 3.5kB/second.

If you create a website that is 5MB in size, then this website will take approximately 25 minutes to download via a 56kbps dial-up connection.

Activity 9

Complete the following table

<table>
<thead>
<tr>
<th>Modem speed (bits per second)</th>
<th>Transfer rate (kilobytes per sec)</th>
<th>Time to transfer 1MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>56 kbps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>128 kbps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>256 kbps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>512 kbps</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The modem/connection speed has implications for streaming video from a website.

Often, a buffer of 1MB is used to pre-load streaming video from the internet prior to it being played. (ie: about 1MB of data is stored in a ‘buffer’ or ‘cache’ before playback starts, allowing the data to be played without interruption)

Activity 10

Assuming that that the connection is transferring an actual rate of 40 000B/second, and that buffering is steady, what is the maximum video screen size that can be used. (allow 0.250kB/sec for audio transfer, assume frame rate of 30 and bit depth of 24bits/pixel)

A good discussion on data transfer rate is available in the following link. 
http://www.planetoftunes.com/computer/datarate.html
Identifying memory requirement - audio.

Sound is a natural phenomenon that needs to be converted from an analogue to digital format for use in multimedia presentations.

This process is called digitisation and is summarised well in the following three websites:

- [http://www.dolphinmusic.co.uk/page/shop/news_story/a/news_id/e/120](http://www.dolphinmusic.co.uk/page/shop/news_story/a/news_id/e/120)
- [http://www.planetoftunes.com/digiaudio/how_a_to_d.html](http://www.planetoftunes.com/digiaudio/how_a_to_d.html)

MP3 is the most common audio format and is based upon a proprietary codec. A stereo file uses approximately 1MB/minute, which is much smaller than the raw data.

Compact Discs are an uncompressed format that uses approximately 10MB per minute.

$$\text{Raw audio file size} = \frac{\text{Sampling rate} \times \text{Time (sec)} \times \text{bit depth} \times \text{No. channels}}{8 \ (= \ conversion \ of \ bits \ to \ bytes)}$$

Sample rate, as identified in the above websites, is typically 44000 for good quality sound. Bit depths of 16 allow sounds to about 90dB to be recorded, bit depths of 24 allow the full volume of sound to be recorded.

**Activity 11**

From the three websites above, identify the sampling rate used for CD production, the bit rate used on CDs and, assuming a stereo sound (2 channel), calculate the exact uncompressed file size per minute of music on a CD.
Activity 12

Visit the following website and listen to the simulations of speech at 1, 2, 4, 6 and 8 channels (individual frequency ranges)
http://www.utdallas.edu/~loizou/cimplants/cdemos.htm

At what point are you able to understand the sentences?

Do you feel that the statement that 8 channels are suited to the cochlear implant?

Justify your answer.

Activity: 13

Visit the following website and confirm the effect of altering the sampling rate and/or bit depth on sound quality.


Confirm the impact of MP3 encoding on file size and file quality from the practical examples given in the above website.

From what you read in the introductory website, http://www.planetoftunes.com/digiaudio/how_a_to_d.html, try to interpolate the answer from the data you have before you open the answer or listen to the sound file.

Other Resources

The attached website was written by a multimedia author as a costing tool for his professional work.

Suggested Answers

Activity 1

Given that 1 inch = 2.54cm, calculate the number of pixels present in a picture of 6cm high by 10cm wide at 72 dpi.

6cm ÷ 2.54 = 2.36 inches @72dpi = 170 pixels high
10cm ÷ 2.54 = 3.94 inches @72dpi = 284 pixels wide

The picture is 170 pixels high x 284 pixels wide.

It contains (170×284) = 48280 pixels (discrete picture elements.)

Activity 2

Using similar methods to those you used above, what is the number of pixels used to create a picture 6cm high by 10cm wide at 300 dpi.

2.36 inches @300dpi = 708 pixels high
3.94 inches @300dpi = 1182 pixels wide

It contains 836856 pixels

Activity 3

A computer monitor is set to display 800 by 600 pixels. Calculate the total number of pixels that need to be controlled by the CPU.

The number of discrete pixels in this screen is 800 × 600 = 480000 pixels

Activity 4

A computer monitor is set to display 1024 by 768 pixels. Calculate the total number of pixels that need to be controlled by the CPU.

The number of discrete pixels in the display is 1024 × 768 = 786432 pixels
**Activity 5**

Complete the following table:

<table>
<thead>
<tr>
<th>Resolution (dpi)</th>
<th>Suitable for which application?</th>
</tr>
</thead>
<tbody>
<tr>
<td>72 dpi</td>
<td>Display of photographs on computer screen</td>
</tr>
<tr>
<td>150 dpi</td>
<td>Data/images for printing on computer printer</td>
</tr>
<tr>
<td>300 dpi</td>
<td>Recommended minimum resolution for photographs to be photo printed</td>
</tr>
</tbody>
</table>

**Activity 6**

Complete the following table:

<table>
<thead>
<tr>
<th>Extension/file type</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPEG</td>
<td>Best format for compressing photographic images, or those with continual subtle shifts in colour</td>
</tr>
<tr>
<td>PNG</td>
<td>Lower file size than GIF, better format for storing simple graphics (blocks of a single colour) than GIF, gives a cleaner image than JPEG. However, this is not a universal image format and may not be supported in some applications</td>
</tr>
<tr>
<td>GIF</td>
<td>Better format than JPEG for compressing simple graphics with blocks of single colour. Produces a clearer image at smaller file size for simple graphics than JPEG. Universally supported</td>
</tr>
<tr>
<td>BMP</td>
<td>No advantages – raw image data is saved – very large file size requiring high bandwidth.</td>
</tr>
<tr>
<td>SVG</td>
<td>Scalable Vector Graphics – being developed as a replacement for PNG/GIF files and steadily being adopted. Potentially may become industry standard for simple graphics through common adoption</td>
</tr>
</tbody>
</table>
Activity 7

Calculate the raw image file size required for an image of size \(1607 \times 784\) pixels at a colour depth of 24 bits

Raw image file size = \((1607 \times 784 \times 24) \div 8 = \text{Bytes} = 3779664\text{B}\)

= \(3779664/1024 = 3691\text{ kB}\)

=\(3779664/1048576 = 3.6\text{MB}\)

(Note that the space required to store this file as a bitmap is shown in the screenshot above. As with the above example, the bitmap file size of this file is 3kB greater than the amount needed for display of the image data. This is due to other file-specific data stored along with the image data.)

Activity 8

Calculate the amount of memory required to display all data on your computer screen.

As each monitor and system varies, it will need to be determined according to the above exercise.

Activity 9

Complete the following table

<table>
<thead>
<tr>
<th>Modem speed (bits per second)</th>
<th>Transfer rate (kilobytes per sec)</th>
<th>Time to transfer 1MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>56 kbps</td>
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<tr>
<td>128 kbps</td>
<td>7.0</td>
<td>143 seconds</td>
</tr>
<tr>
<td>256 kbps</td>
<td>32</td>
<td>31 seconds</td>
</tr>
<tr>
<td>512 kbps</td>
<td>63</td>
<td>15 seconds</td>
</tr>
</tbody>
</table>
**Activity 10**

Assuming that the connection is transferring an actual rate of 40,000B/second, and that buffering is steady, what is the maximum video screen size that can be used. (allow 0.250kB/sec for audio transfer, assume frame rate of 30 and bit depth of 24 bits/pixel)

Amount of bandwidth available for video transfer = 39750 Bytes/sec

\[39750 \times 8 = 24 \times 30 \times \text{number of pixels}\]

Number of pixels \[= \frac{(39750 \times 8)}{(24 \times 30)}\]

\[= 440 \text{ px}\]

This is a small window of approx 21 pixels by 21 pixels

**** This illustrates why video compression is so important. ****

Assuming that MPEG encoding allows 90% compression and that you are downloading a MPEG, then the number of pixels available now for viewing is

\[440/0.1 = 4400 \text{ px}\]

This is now a screen at 200 by 220 pixels.

**Activity 11**

From the three websites above, identify the sampling rate used for CD production, the bit rate used on CDs and, assuming a stereo sound (2 channel), calculate the exact uncompressed file size per minute of music on a CD

44100 sampling rate, 60 seconds, bit rate of 16

Raw audio file size \[= \frac{(44100 \times 16 \times 2 \times 60)}{8}\]

\[= 10584000 \text{ B}\]

\[= 10.09 \text{ MB}\]
Graphics

- reading and interpretation
- freehand drawing and sketching
- working drawings
  - storyboard, screen design principles, context diagrams, data flow diagrams, system flow diagrams
- computer software graphics
- signage
Processes, tools and machines

**Tools and machines**
- computers capable of multimedia, and
- access to additional equipment that allows the relevant projects to be undertaken, to include modem, CD writer, digital camera, video and in and out cards etc
- colour printers
- scanners & digital cameras
- appropriate software relevant to the project in the areas of authoring, publishing, sound editing, image editing, 2D/3D drawing, web page design

**Processes**
- **storyboarding** in relation to:
  - information
  - entertainment
  - training and development
  - marketing
- **image creation/editing**
- **sound creation/editing**
- **publishing/page layout**
- **authoring**
- **copyright**

**Materials and resources**
- **file formats/compatibility**
- **image formats**
- **pictorial 2D/3D**
- **video formats**
- **text creation/formats/importing**
- **sound files**
- **world wide web resources**
- **paper types and print resolution**
- **digital libraries** (clip art, fonts, images, photos, sounds)
Computers Capable Of Multimedia
CPU

Basic structure
A processor's major functional components are:

- Core: The heart of a modern is the execution unit. The Pentium has two parallel integer pipelines enabling it to read, interpret, execute and despatch two instructions simultaneously.
- Branch Predictor: The branch prediction unit tries to guess which sequence will be executed each time the program contains a conditional jump, so that the Prefetch and Decode Unit can get the instructions ready in advance.
- Floating Point Unit: The third execution unit in a Pentium, where non-integer calculations are performed.
- Level 1 Cache: The Pentium has two on-chip caches of 8KB each, one for code and one for data, which are far quicker than the larger external secondary cache.
- Bus Interface: This brings a mixture of code and data into the CPU, separates the two ready for use, and then recombines them and sends them back out.

All the elements of the processor stay in step by use of a "clock" which dictates how fast it operates. The very first microprocessor had a 100KHz clock, whereas the Pentium Pro uses a 3.6GHz clock, which is to say it "ticks" 3600 million times per second. As the clock "ticks", various things happen. The Program Counter (PC) is an internal memory location which contains the address of the next instruction to be executed. When the time comes for it to be executed, the Control Unit transfers the instruction from memory into its Instruction Register (IR).

At the same time, the PC is incremented so that it points to the next instruction in sequence; now the processor executes the instruction in the IR. Some instructions are handled by the Control Unit itself, so if the instruction says "jump to location 2749", the value of 2749 is written to the PC so that the processor executes that instruction next.

Many instructions involve the arithmetic and logic unit (ALU). This works in conjunction with the General Purpose Registers - temporary storage areas which can be loaded from memory or written to memory. A typical ALU instruction might be to add the contents of a...
memory location to a general purpose register. The ALU also alters the bits in the Status Register (SR) as each instruction is executed; this holds information on the result of the previous instruction. Typically, the SR has bits to indicate a zero result, an overflow, a carry and so forth. The control unit uses the information in the SR to execute conditional instructions such as “jump to address 7410 if the previous instruction overflowed”.

PCI slots
AGP (graphic) slot
RAM slots
Dual core Pentium processor
RAM

Memory Basics

Although memory is technically any form of electronic storage, it is used most often to identify fast, temporary forms of storage. If your computer’s CPU had to constantly access the hard drive to retrieve every piece of data it needs, it would operate very slowly. When the information is kept in memory, the CPU can access it much more quickly. Most forms of memory are intended to store data temporarily.

As you can see in the diagram above, the CPU accesses memory according to a distinct hierarchy. Whether it comes from permanent storage (the hard drive) or input (the keyboard), most data goes in random access memory (RAM) first. The CPU then stores pieces of data it will need to access, often in a cache, and maintains certain special instructions in the register.
All of the components in your computer, such as the CPU, the hard drive and the operating system, work together as a team, and memory is one of the most essential parts of this team. From the moment you turn your computer on until the time you shut it down, your CPU is constantly using memory. Let's take a look at a typical scenario:

- You turn the computer on.
- The computer loads data from read-only memory (ROM) and performs a power-on self-test (POST) to make sure all the major components are functioning properly. As part of this test, the memory controller checks all of the memory addresses with a quick read/write operation to ensure that there are no errors in the memory chips. Read/write means that data is written to a bit and then read from that bit.
- The computer loads the basic input/output system (BIOS) from ROM. The BIOS provides the most basic information about storage devices, boot sequence, security, Plug and Play (auto device recognition) capability and a few other items.
- The computer loads the operating system (OS) from the hard drive into the system's RAM. Generally, the critical parts of the operating system are maintained in RAM as long as the computer is on. This allows the CPU to have immediate access to the operating system, which enhances the performance and functionality of the overall system.
- When you open an application, it is loaded into RAM. To conserve RAM usage, many applications load only the essential parts of the program initially and then load other pieces as needed.
- After an application is loaded, any files that are opened for use in that application are loaded into RAM.
- When you save a file and close the application, the file is written to the specified storage device, and then it and the application are purged from RAM.

Every time something is loaded or opened, it is placed into RAM. This simply means that it has been put in the computer's temporary storage area so that the CPU can access that information more easily. The CPU requests the data it needs from RAM, processes it and writes new data back to RAM in a continuous cycle. This shuffling of data between the CPU and RAM happens millions of times every second. When an application is closed, it and any accompanying files are usually purged (deleted) from RAM to make room for new data. If the changed files are not saved to a permanent storage device before being purged, they are lost.

**The Need for Speed**

One common question about desktop computers that comes up all the time is, "Why does a computer need so many memory systems?" A typical computer has:

- Level 1 and level 2 caches
- Normal system RAM
- Virtual memory
- A hard disk
Fast, powerful CPUs need quick and easy access to large amounts of data in order to maximize their performance. If the CPU cannot get to the data it needs, it literally stops and waits for it. Modern CPUs running at speeds of about 3.6 gigahertz can consume massive amounts of data -- potentially billions of bytes per second. The problem that computer designers face is that memory that can keep up with a 3.6-gigahertz CPU is extremely expensive -- much more expensive than anyone can afford in large quantities.

Computer designers have solved the cost problem by "tiering" memory -- using expensive memory in small quantities and then backing it up with larger quantities of less expensive memory.

The cheapest form of read/write memory in wide use today is the hard disk. Hard disks provide large quantities of inexpensive, permanent storage. You can buy hard disk space for pennies per megabyte, but it can take a good bit of time (approaching a second) to read a megabyte off a hard disk. Because storage space on a hard disk is so cheap and plentiful, it forms the final stage of a CPUs memory hierarchy, called virtual memory.

The next level of the hierarchy is RAM. The bit size of a CPU tells you how many bytes of information it can access from RAM at the same time. For example, a 16-bit CPU can process 2 bytes at a time (1 byte = 8 bits, so 16 bits = 2 bytes), and a 64-bit CPU can process 8 bytes at a time.

Megahertz (MHz) is a measure of a CPU's processing speed, or clock cycle, in millions per second. So, a 64-bit 3-GHz Pentium can potentially process 8 bytes simultaneously, 3 billion times per second (possibly more based on pipelining)! The goal of the memory system is to meet those requirements.

A computer's system RAM alone is not fast enough to match the speed of the CPU. That is why you need a cache. However, the faster RAM is, the better.

System RAM speed is controlled by bus width and bus speed. Bus width refers to the number of bits that can be sent to the CPU simultaneously, and bus speed refers to the number of times a group of bits can be sent each second. A bus cycle occurs every time data travels from memory to the CPU. For example, a 100-MHz 32-bit bus is theoretically capable of sending 4 bytes (32 bits divided by 8 = 4 bytes) of data to the CPU 100 million times per second, while a 66-MHz 16-bit bus can send 2 bytes of data 66 million times per second. If you do the math, you'll find that simply changing the bus width from 16 bits to 32 bits and the speed from 66 MHz to 100 MHz in our example allows for three times as much data (400 million bytes versus 132 million bytes) to pass through to the CPU every second.

In reality, RAM doesn't usually operate at optimum speed. Latency changes the equation radically. Latency refers to the number of clock cycles needed to read a bit of information. For example, RAM rated at 100 MHz is capable of sending a bit in 0.00000001 seconds, but may take 0.00000005 seconds to start the read process for the first bit. To compensate for latency, CPUs uses a special technique called burst mode.

Burst mode depends on the expectation that data requested by the CPU will be stored in sequential memory cells. The memory controller anticipates that whatever the CPU is working on will continue to come from this same series of memory addresses, so it reads
several consecutive bits of data together. This means that only the first bit is subject to the full effect of latency; reading successive bits takes significantly less time.

Burst mode is often used in conjunction with pipelining, another means of minimizing the effects of latency. Pipelining organizes data retrieval into a sort of assembly-line process. The memory controller simultaneously reads one or more words from memory, sends the current word or words to the CPU and writes one or more words to memory cells. Used together, burst mode and pipelining can dramatically reduce the lag caused by latency.

So why wouldn't you buy the fastest, widest memory you can get? The speed and width of the memory's bus should match the system's bus. You can use memory designed to work at 100 MHz in a 66-MHz system, but it will run at the 66-MHz speed of the bus so there is no advantage, and 32-bit memory won't fit on a 16-bit bus.

**Cache and Registers**

Even with a wide and fast bus, it still takes longer for data to get from the memory card to the CPU than it takes for the CPU to actually process the data. Caches are designed to alleviate this bottleneck by making the data used most often by the CPU instantly available. This is accomplished by building a small amount of memory, known as primary or level 1 cache, right into the CPU. Level 1 cache is very small, normally ranging between 2 kilobytes (KB) and 64 KB.

The secondary or level 2 cache typically resides on a memory card located near the CPU. The level 2 cache has a direct connection to the CPU. A dedicated integrated circuit on the motherboard, the L2 controller, regulates the use of the level 2 cache by the CPU. Depending on the CPU, the size of the level 2 cache ranges from 256 KB to 2 megabytes (MB). In most systems, data needed by the CPU is accessed from the cache approximately
95 percent of the time, greatly reducing the overhead needed when the CPU has to wait for data from the main memory.

Some inexpensive systems dispense with the level 2 cache altogether. Many high performance CPUs now have the level 2 cache actually built into the CPU chip itself. Therefore, the size of the level 2 cache and whether it is onboard (on the CPU) is a major determining factor in the performance of a CPU.

A particular type of RAM, static random access memory (SRAM), is used primarily for cache. SRAM uses multiple transistors, typically four to six, for each memory cell. It has an external gate array known as a bistable multivibrator that switches, or flip-flops, between two states. This means that it does not have to be continually refreshed like DRAM. Each cell will maintain its data as long as it has power. Without the need for constant refreshing, SRAM can operate extremely quickly. But the complexity of each cell make it prohibitively expensive for use as standard RAM.

The SRAM in the cache can be asynchronous or synchronous. Synchronous SRAM is designed to exactly match the speed of the CPU, while asynchronous is not. That little bit of timing makes a difference in performance. Matching the CPU's clock speed is a good thing, so always look for synchronized SRAM.

The final step in memory is the registers. These are memory cells built right into the CPU that contain specific data needed by the CPU, particularly the arithmetic and logic unit (ALU). An integral part of the CPU itself, they are controlled directly by the compiler that sends information for the CPU to process. See How Microprocessors Work for details on registers.

**Types of Memory**

Memory can be split into two main categories: volatile and nonvolatile. Volatile memory loses any data as soon as the system is turned off; it requires constant power to remain viable. Most types of RAM fall into this category.

Nonvolatile memory does not lose its data when the system or device is turned off. A number of types of memory fall into this category. The most familiar is ROM, but Flash memory storage devices such as CompactFlash or SmartMedia cards are also forms of nonvolatile memory.
A video card consists of a printed circuit board on which the components are mounted. These include:

**Graphics processing unit (GPU)**

A GPU is a dedicated graphics microprocessor optimized for floating point calculations which are fundamental to 3D graphics rendering. The main attributes of the GPU are the core clock rate, which typically ranges from 250 MHz to 850 MHz, and the number of pipelines (vertex and fragment shaders), which translate a 3D image characterized by vertices and lines into a 2D image formed by pixels.

**Video BIOS**

The video BIOS or firmware contains the basic program that governs the video card's operations and provides the instructions that allow the computer and software to interface with the card. It may contain information on the memory timing, operating speeds and voltages of the graphics processor and RAM and other information. It is sometimes possible to change the BIOS (e.g., to enable factory-locked settings for higher performance) although this is typically only done by video card overclockers, and has the potential to irreversibly damage the card.
Video memory

If the video card is integrated in the motherboard, it may use the computer RAM (lower throughput). If it is not integrated, the video card will have its own video memory, called Video RAM. The memory capacity of most modern video cards range from 128 MB to 2.0 GB. Since video memory needs to be accessed by the GPU and the display circuitry, it often uses special high speed or multi-port memory, such as VRAM, WRAM, SGRAM, etc. Around 2003, the video memory was typically based on DDR technology. During and after that year, manufacturers moved towards DDR2, GDDR3 and GDDR4 even GDDR5 utilized most notably by the ATI Radeon HD 4870. The memory clock rate in modern cards are generally between 400 MHz and 2.4 GHz.

Video memory may be used for storing other data as well as the screen image, such as the Z-buffer, which manages the depth coordinates in 3D graphics, textures, vertex buffers, and compiled shader programs.

<table>
<thead>
<tr>
<th>Type</th>
<th>Memory clock rate (MHz)</th>
<th>Bandwidth (GB/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDR</td>
<td>166 - 950</td>
<td>1.2 - 30.4</td>
</tr>
<tr>
<td>DDR2</td>
<td>533 - 1000</td>
<td>8.5 - 16</td>
</tr>
<tr>
<td>GDDR3</td>
<td>700 - 1800</td>
<td>5.6 - 54.4</td>
</tr>
<tr>
<td>GDDR4</td>
<td>1600 - 2400</td>
<td>64 - 156.6</td>
</tr>
<tr>
<td>GDDR5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Outputs
The most common connection systems between the video card and the computer display are:

<table>
<thead>
<tr>
<th>Connection</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD-15</td>
<td>Analog-based standard adopted in the late 1980s designed for CRT displays, also called VGA connector. Some problems of this standard are electrical noise, image distortion and sampling error evaluating pixels.</td>
</tr>
<tr>
<td>DVI</td>
<td>Digital-based standard designed for displays such as flat-panel displays (LCDs, plasma screens, wide High-definition television displays) and video projectors. It avoids image distortion and electrical noise, corresponding each pixel from the computer to a display pixel, using its native resolution.</td>
</tr>
<tr>
<td>Video In Video Out (VIVO) for S-Video, Composite video and Component video</td>
<td>Included to allow the connection with televisions, DVD players, video recorders and video game consoles. They often come in two 9-pin Mini-DIN connector variations, and the VIVO splitter cable generally comes with either 4 connectors (S-Video in and out + composite video in and out) or 6 connectors (S-Video in and out + component P_B out + component P_R out + component Y out (also composite out) + composite in).</td>
</tr>
</tbody>
</table>

9-pin VIVO for S-Video (TV-out), DVI for HDTV and HD-15 for VGA outputs.

Other types of connection systems

**Composite video**

Analog system, with lower resolution. It uses RCA connector.

**Component video**

It has three cables, each with RCA connector (Y,Cb,Cr); it is used in projectors, DVD players and some televisions.
USB

Universal Serial Bus, or USB, is the new standard for peripheral connection to PCs. USB devices range from scanners to printers to storage devices. Supports data transfer up to 12 mbps and each port can support up to 127 devices.

USB 1.1 allowed a maximum transfer rate of 12Mbits/second. That rate is now called 'USB.' Though some manufacturers label their products Full-Speed USB. Note that this seems a bit deceptive. It’s easy to mistake Full-Speed for Hi-Speed.

You won’t be fooled from now on as you now aware that Full Speed USB is only 12Mbits/second where Hi-Speed USB mode is capable of a much faster 480Mbits/second.

IEEE 1394

IEEE 1394 is the standard for what is commonly referred to as “Firewire”.

IEEE 1394, or Firewire, is a high speed connector for data intensive applications such as video editing or external storage devices.

A very fast external bus standard that supports data transfer rates of up to 400Mbps (in 1394a) and 800Mbps (in 1394b). Products supporting the 1394 standard go under different names, depending on the company.

A single 1394 port can be used to connect up 63 external devices. In addition to its high speed, 1394 also supports isochronous data -- delivering data at a guaranteed rate. This makes it ideal for devices that need to transfer high levels of data in real-time, such as video devices.

- FireWire is officially known as IEEE 1394. It transfers data at up to 400 megabits per second (Mbps) or 800 Mbps.
- Hi-Speed USB transmits data at up to 480Mbps. It's part of the USB 2.0 specification that can handle data transfer at three speeds: low (1.5Mbps), full (12Mbps) and high (480Mbps).
- You can find FireWire and USB models of almost all types of major peripherals.
Question: Which is faster Hi-Speed USB 2.0 or FireWire?
Answer: In sustained throughput FireWire is faster than USB 2.0.

Question: If Hi-Speed USB 2.0 is a 480 Mbps interface and FireWire is a 400 Mbps interface, how can FireWire be faster?
Answer: Differences in the architecture of the two interfaces have a huge impact on the sustained throughput.

FireWire vs. USB 2.0 - Architecture

- FireWire, uses a "Peer-to-Peer" architecture in which the peripherals are intelligent and can negotiate bus conflicts to determine which device can best control a data transfer
- Hi-Speed USB 2.0 uses a "Master-Slave" architecture in which the computer handles all arbitration functions and dictates data flow to, from and between the attached peripherals (adding additional system overhead and resulting in slower data flow control)

FireWire vs. USB 2.0 Hard Drive Performance Comparison
Read and write tests to the same IDE hard drive connected using FireWire and then Hi-Speed USB 2.0 show:

Read Test:
- 5000 files (300 MB total) FireWire was 33% faster than USB 2.0
- 160 files (650MB total) FireWire was 70% faster than USB 2.0

Write Test:
- 5000 files (300 MB total) FireWire was 16% faster than USB 2.0
- 160 files (650MB total) FireWire was 48% faster than USB 2.0

Question: So which products should I choose FireWire or Hi-Speed USB 2.0?
Answer: Often the choice will be made for you by the product itself. Some types of products are only available with the FireWire interface and some only with USB.

For all out sustained throughput, as shown above a FireWire external hard drive will provide the best performance. But for convenience and compatibility between multiple computers a USB 2.0 external hard drive would probably be the better choice (since practically every computer has a USB port).
Motherboard interface
Chronologically, connection systems between video card and motherboard were, mainly:

- PCI: 32 bit, 33 MHz. Replaced the previous buses from 1993. PCI allowed dynamic connectivity between devices, avoiding the jumpers manual adjustments. PCI-X was a version introduced in 1998 that improved PCI to 64 bits and 133 MHz.
- UPA: A interconnect bus architecture introduced by Sun Microsystems in 1995. 64 bits, initially 67 or 83 MHz.
- USB: Mostly used for other types of devices, but there are USB displays.
- AGP: First used in 1997. Dedicated to graphics bus, 32 bits, 66 MHz.
- PCI-Express: Point to point interface, released in 2004. In 2006 provided double data transfer rate of AGP. Should not be confused with PCI-X, an enhanced version of the original PCI specification.

Cooling devices
Video cards may use a lot of electricity, which is converted into heat. If the heat isn't dissipated, the video card could overheat and be damaged. Cooling devices are incorporated to transfer the heat elsewhere. Three types of cooling devices are commonly used on video cards:

- Heat sink: a heat sink is a passive cooling device. It conducts heat away from the graphics card's core, or memory, by using a heat conductive metal, most commonly aluminum or copper, sometimes in combination with heat pipes. It uses air (most common) or in extreme cooling situations, water (see water block), to remove the heat from the card. When air is used, a fan is often used to increase cooling effectiveness.
- Computer fan: an example of an active cooling part. It is usually used with a heatsink. Due to the moving parts, a fan requires maintenance and possible replacement. Enthusiasts may change the fan speed or fan for more efficient or quieter cooling.
- Water block: A water block is a heat sink suited to use water instead of air. It is mounted on the graphics processor and has a hollow inside. Water is pumped through the water block, transferring the heat into the water, which is then usually cooled in a radiator. This is the most effective cooling solution without extreme modification.

Power demand
As the processing power of video cards has increased, so has their demand for electrical power. Present fast video cards tend to consume a great deal of power. While CPU and power supply makers have recently moved toward higher efficiency, power demands of GPUs have continued to rise, so the video card may be the biggest electricity user in a computer. Although power supplies are increasing their power too, the bottleneck is due to the PCI-Express connection, which is limited to supplying 75 W. Nowadays, video cards with a power consumption over 75 watts usually include a combination of six pin (75W) or eight pin (150W) sockets that connect directly to the power supply to supplement power.
Sound Card

Before the arrival of sound cards, personal computers (PCs) were limited to beeps from a tiny speaker on the motherboard. In the late 1980s, sound cards ushered in the multimedia PC and took computer games to a whole different level.

In 1989, Creative Labs introduced the Creative Labs SoundBlaster® card. Since then, many other companies have introduced sound cards, and Creative has continued to improve the SoundBlaster line.

Anatomy of a Sound Card

A typical sound card has:

• a digital signal processor (DSP) that handles most computations
• a digital to analog converter (DAC) for audio leaving the computer
• an analog-to-digital converter (ADC) for audio coming into the computer
• read-only memory (ROM) or Flash memory for storing data
• musical instrument digital interface (MIDI) for connecting to external music equipment (for many cards, the game port is also used to connect an external MIDI adapter)
• jacks for connecting speakers and microphones, as well as line in and line out
• a game port for connecting a joystick or gamepad

Sound cards usually plug into a PCI slot on the motherboard. Many of the computers available today incorporate the sound card as a chipset right on the motherboard. This leaves another slot open for other peripherals, but will not usually provide the options or capacity provided by a card.

<table>
<thead>
<tr>
<th>Sound cards may be connected to:</th>
<th>amplified speakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• headphones</td>
<td>• a digital input source</td>
</tr>
<tr>
<td>• an analog input source</td>
<td>• digital audiotape (DAT)</td>
</tr>
<tr>
<td>• microphone</td>
<td>• CD-ROM drive</td>
</tr>
<tr>
<td>• radio</td>
<td></td>
</tr>
<tr>
<td>• TV in</td>
<td></td>
</tr>
<tr>
<td>• CD player</td>
<td></td>
</tr>
<tr>
<td>• an analog output device – cassette player</td>
<td>• a digital output device</td>
</tr>
<tr>
<td></td>
<td>• DAT</td>
</tr>
<tr>
<td></td>
<td>• CD recordable (CD-R)</td>
</tr>
</tbody>
</table>

Many sound cards offer multi-speaker, surround output and digital interface through a jack. For audiophiles, there is a new generation of **digital sound cards**. A digital sound card is practical for applications that need digital sound, such as CD-R. Staying digital without any conversion to or from analog helps prevent what is called “generational loss.” Digital sound cards have provisions for digital sound input and output, so you can transfer data from DVD or CD directly to your hard disk in your PC.
Catching The Wave
Typically, a sound card can do four things with sound:

- play pre-recorded music (from CDs or sound files, such as wav or MP3), games or DVDs
- record audio in various media from external sources (microphone or tape player)
- synthesize sounds
- process existing sounds

Very sophisticated sound cards have more support for MIDI instruments. Using a music program, a MIDI-equipped music instrument can be attached to the sound card to allow you to see on the computer screen the music score of what you're playing.

Producing Sound
Let's say you speak into your computer's microphone. A sound card creates a sound file in wav format from the data input through the microphone. The process of converting that data into a file to be recorded to the hard disk is:

1. The sound card receives a continuous, analog-waveform input signal from the microphone jack. The analog signals received vary in both amplitude and frequency.
2. Software in the computer selects which input(s) will be used, depending on whether the microphone sound is being mixed with a CD in the CD-ROM drive.
3. The mixed, analog waveform signal is processed in real-time by an analog-to-digital converter (ADC) circuit chip, creating a binary (digital) output of 1s and 0s.
4. The digital output from the ADC flows into the DSP. The DSP is programmed by a set of instructions stored on another chip on the sound card. One of the functions of the DSP is to compress the now-digital data in order to save space. The DSP also allows the computer's processor to perform other tasks while this is taking place.
5. The output from the DSP is fed to the computer's data bus by way of connections on the sound card (or traces on the motherboard to and from the sound chipset).
6. The digital data is processed by the computer's processor and routed to the hard-disk controller. It is then sent on to the hard-disk drive as a recorded wav file.

To listen to a prerecorded wav file, the process is simply reversed:

1. The digital data is read from the hard disk and passed on to the central processor.
2. The central processor passes the data to the DSP on the sound card.
3. The DSP uncompressed the digital data.
4. The uncompressed, digital data-stream from the DSP is processed in real-time by a digital-to-analog converter (DAC) circuit chip, creating an analog signal that you hear in the headphones or through the speakers, depending on which is connected to the sound-card's headphone jack.
Colour Printers

Printer Resolution (dpi)

While digital cameras use pixels to measure image resolution, printer resolution is based on the number of dots per inch (dpi) the printer lays down on paper. The higher the dpi, the smaller the dot, and the harder it is to discern one dot from another with normal viewing. Very high-quality, photorealistic ink-jet printers produce dots so small that you can only see them with a magnifying loupe, but there are many levels of acceptable printer quality between high-end and low-end models.

Printer resolutions vary from 300 to 1,400 dpi and higher, depending on the technology used to create the dot (see "Printer Technologies" below) and the size of the nozzles or heating elements in the print head. A printer that delivers 600 dpi resolution is generally considered photo-quality, but there are other factors that influence how a print looks to the naked eye. The kind of paper you use to print the image has a dramatic effect on print quality, as does the number of colors the printer uses, and the way the ink is applied. Read on to find out more about these factors.

How Many Colors?

Most digital printers use a combination of three, four, or six colors to print full-color images. Ink-jet printers dispense each color individually, either from a single chamber in a multi-chambered ink cartridge, or from a single ink cartridge that can be swapped out when one color gets low. Dye-sub printers use heat-transfer ribbons, each dispensing a different colored dye. All printers use cyan, magenta, and yellow -- the three primary colors used in printing -- as their base colors, with a few variations as noted below:

- Three color printers: Cyan, magenta, and yellow are known as "subtractive" colors. If you combine equal amounts of these three colors, you get black -- the absence of all color. Based on this theory, a CMY printer should be able to produce black without any problem. In the real world, however, CMY blacks usually come out looking muddy or gray, so the printing industry has traditionally added a "composite" black ink to the mix to help clean up the shadows and dark areas of an image. If you want high-quality photos, we recommend that you avoid three-color printers.

- Four color printers: Like the professional printing presses mentioned above, most high-quality digital printers use a combination of cyan, magenta, yellow, and black (CMYK) inks to recreate -- as closely as possible -- the full spectrum of tones and colors that you see when you take a picture. When shopping for a digital printer, look for one that uses at least four colors.

- Six color printers: Many printer manufacturers have expanded the traditional CMYK ink set to include two additional colors -- light cyan and light magenta. These two color variations make it easier for the printer to reproduce light-colored image tones, without having to leave excess white space between the ink dots. The result is an image with a more continuous-tone quality.

Ultraviolet Coating

Concerns with print permanency and the adverse effects of UV light have prompted a great deal of research into methods of protecting digital prints. In addition to improvements in ink quality, some printer manufacturers have added a UV coating to the print production process. Originally introduced in high-end, dye-sub printers, the UV layer may add decades to a print's life expectancy.
Choosing the Right Paper

Paper is a key component to the quality of a digital print. You can't expect to obtain good results from an inexpensive, porous paper that is not designed for printing photo-quality images. Your best bet is to buy papers (and inks) recommended by the printer manufacturer, which in most cases, will be made or marketed by the manufacturer itself. Its papers are optimized for use with its printers, and will probably give you the best results.

Once you become familiar with your new printer, then you can start experimenting with different brands and textures of papers. There are dozens of creative possibilities out there, especially in the realm of ink-jet printing.

The paper you use on an inkjet printer greatly determines the quality of the image. Standard copier paper works, but doesn't provide as crisp and bright an image as paper made for an inkjet printer. There are two main factors that affect image quality:

- **Brightness**
- **Absorption**

The **brightness** of a paper is normally determined by how rough the surface of the paper is. A course or rough paper will scatter light in several directions, whereas a smooth paper will reflect more of the light back in the same direction. This makes the paper appear brighter, which in turn makes any image on the paper appear brighter. You can see this yourself by comparing a photo in a newspaper with a photo in a magazine. The smooth paper of the magazine page reflects light back to your eye much better than the rough texture of the newspaper. Any paper that is listed as being *bright* is generally a smoother-than-normal paper.

The other key factor in image quality is **absorption**. When the ink is sprayed onto the paper, it should stay in a tight, symmetrical dot. The ink should not be absorbed too much into the paper. If that happens, the dot will begin to **feather**. This means that it will spread out in an irregular fashion to cover a slightly larger area than the printer expects it to. The result is an page that looks somewhat fuzzy, particularly at the edges of objects and text.

Imagine that the dot on the left is on coated paper and the dot on the right is on low-grade copier paper. Notice how irregular and larger the right dot is compared to the left one.
As stated, feathering is caused by the paper absorbing the ink. To combat this, high-quality inkjet paper is coated with a waxy film that keeps the ink on the surface of the paper. Coated paper normally yields a dramatically better print than other paper. The low absorption of coated paper is key to the high resolution capabilities of many of today’s inkjet printers. For example, a typical Epson inkjet printer can print at a resolution of up to 720x720 dpi on standard paper. With coated paper, the resolution increases to 1440x720 dpi. The reason is that the printer can actually shift the paper slightly and add a second row of dots for every normal row, knowing that the image will not feather and cause the dots to blur together.

Inkjet printers are capable of printing on a variety of media. Commercial inkjet printers sometimes spray directly on an item like the label on a beer bottle. For consumer use, there are a number of specialty papers, ranging from adhesive-backed labels or stickers to business cards and brochures. You can even get iron-on transfers that allow you to create an image and put it on a T-shirt!

Printer Technologies
There are many types of digital color printers on the market. Each approaches the task of depositing ink or dye on paper in a different fashion. The following are the three most common types of printers used for digital color printing. Among them you'll find models priced for the amateur, advanced-amateur, and professional photography markets.

Ink-Jet
Ink-jet printers operate exactly as their name implies: Ink is sprayed onto the printing substrate through tiny nozzles (about the diameter of a human hair), depositing small droplets of color as they move over the image area. These nozzles are part of a cartridge assembly that makes up the "print head," which passes back and forth across the paper horizontally, squirting ink as it goes along. When one strip of paper is covered with enough ink to form that portion of the image, the printer's "stepper motor" advances the paper to the next strip, so the print head can continue to deposit ink until it has covered the entire sheet of paper.

There are several methods by which ink is transferred from the nozzle to the paper in ink-jet printing. Thermal ink-jet technology, originally developed by Canon U.S.A. as "bubble-jet" printing, uses heat to force the ink through the nozzle openings. Canon has refined the thermal process so that its current bubble-jet printers are capable of producing variable-size dots instead of the uniform size dots that are usually associated with this technology. By varying the dot size, the printers are better able to manipulate ink density. Resolutions for thermal ink-jet printers usually start at 300 dpi.

Micro Piezo technology, a development of Epson America, employs an electrical charge to deliver the ink to the substrate. This method allows more precise control over the size and shape of the ink droplets, which are generally smaller than dots created by the thermal ink-jet process. Smaller dots mean that you can fit more of them per inch, and therefore achieve higher image resolution (typically starting at 720 dpi). Another benefit of the Piezo method is that the ink does not have to stand up to the high temperatures associated with thermal ink-jet technology, so there is more latitude for developing new and improved ink sets.
Dye-Sublimation

Dye-sublimation was long considered the "only" technology capable of producing real photo-quality digital prints. Based on a heat transfer process, thermal dye-sublimation uses thousands of tiny heating elements that come in contact with a "donor ribbon," releasing a gaseous dye that is transferred to the paper one color at a time. Each heating element is controlled individually by electronic impulses from the printer's internal processor. The gaseous nature of the dyes allows them to blend seamlessly on the printing substrate, producing continuous-tone prints that are nearly indiscernible from conventional photographic prints.

Early dye-sub printers were large, bulky, and cost tens of thousands of dollars. Because each color ribbon is processed individually (one pass each for cyan, magenta, yellow, and -- in some printers -- black), the dye-sublimation process can also be somewhat time-consuming. However, the results usually speak for themselves, and some of the newer, less expensive consumer-level dyesubs, like those made by Olympus for use with its digital camera line, are beginning to gain popularity.

Thermo Autochrome

Thermo autochrome is a relatively new printer technology that uses heat-sensitive pigment layers incorporated directly into the paper. The three color layers -- cyan, magenta, and yellow -- are each sensitive to a different temperature. The printer selectively heats areas of the paper, one color at a time, to activate and then fix the pigments with ultraviolet light. Fuji Photo Film U.S.A. uses thermo autochrome technology in its NC and NX printers specifically designed for use as companion printers with its popular line of digital cameras.
Dithering is the use of scattered dots, somewhat randomized instead of ordered halftone grids, which looks smoother on low resolution devices. The printer's limited combinations of three ink colors can rarely make the exact color for an image pixel. There is usually an error, a difference in the desired color of the image pixel and what the printer's dots of three colors can do.

Error diffusion means that the color error difference is carried over to four adjacent image pixels, one to the right and three below the pixel in error. Those next pixels are intentionally overcompensated in the opposite amount. If the possible dot combination for one pixel is not red enough, the next neighbouring pixels are made overly red, so to speak. Then their own error term is carried over to their neighbours in turn. As this process moves across the image, compensating the color error, it all balances out and we see the right color.

Stop and think a second about what you see. Photo quality on an inkjet printer needs images around 250 dpi. However, video screen images are displayed on the monitor at about 75 to 100 ppi apparent size. Yet the video image usually looks better. The big difference is that every RGB phosphor dot on the screen can reproduce ANY of the 256 intensity values. But a printer's ink dot can only be either present or absent (two values). Inkjets must simulate pixel colors by using combinations of several ink dots of only the four CMYK colors. Inkjet printers are relatively crude devices, and instead of more spatial resolution, what they really need is more color depth or color resolution - they need a better way to reproduce the color of an image pixel in a very small space on paper. They can't use more pixels, smaller pixels simply limit even more their ability to accurately simulate the correct color of each existing image pixel.

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**How to Determine Print Resolution**

You don't need a high-resolution printer to make great pictures. In fact, the higher the printer resolution you use, the more pixels you'll need in your original image file to produce a decent size print. That's because the image file size (in pixels), divided by the printer resolution (in dots per inch), determines the final print size. For example, if the image file size is 1,478 x 1,280 pixels, and you print the file at 163 dpi, the final print size will be 9 x 7.8 inches:

\[
1,478 \div 163 = 9.01 \text{ and } 1,280 \div 163 = 7.85, \text{ or } 9 \times 7.8 \text{ inches}
\]

If your printer resolution is 300 dpi, you'll have higher resolution (more dots per inch laid down on the paper), but you'll also have a smaller print size, because:

\[
1,478 \div 300 = 4.92 \text{ and } 1,280 \div 300 = 4.26, \text{ or } 4.9 \times 4.2 \text{ inches}
\]

So if you decide to invest in a high-resolution printer, make sure that you have the image file sizes to support it.
Scanners

Scanners are the critical link between the non-digital and the digital world. Any picture or document can be turned into a digital format with a scanner.

The core component of the scanner is the **CCD array**. CCD is the most common technology for image capture in scanners. CCD is a collection of tiny light-sensitive diodes, which convert photons (light) into electrons (electrical charge). These diodes are called **photosites**. In a nutshell, each photosite is sensitive to light -- the brighter the light that hits a single photosite, the greater the electrical charge that will accumulate at that site.

- A **lamp** is used to illuminate the document.
- The entire mechanism (mirrors, lens, filter and CCD array) make up the **scan head**. The scan head is moved slowly across the document by a **belt** that is attached to a stepper motor.
- The image of the document is reflected by an angled **mirror** to another mirror. I
- The last mirror reflects the image onto a **lens**. The lens focuses the image through a **filter** on the CCD array.
- The lens splits the image into three smaller versions of the original. Each smaller version passes through a color filter (either red, green or blue) onto a discrete section of the CCD array. The scanner combines the data from the three parts of the CCD array into a single full-color image.

The TWAIN driver acts as an interpreter between any application that supports the TWAIN standard and the scanner. This means that the application does not need to know the specific details of the scanner in order to access it directly. For example, you can choose to acquire an image from the scanner from within Adobe Photoshop because Photoshop supports the TWAIN standard.

OCR allows you to scan in words from a document and convert them into computer-based text. It uses an averaging process to determine what the shape of a character is and match it to the correct letter or number.
Most flatbed choices are 600 or 1200 dpi now, and some are 2400 dpi. You won't need more than 300 dpi for scanning photo prints, or 600 dpi for line art documents, assuming printing at original size. 1200 and 2400 dpi would be used for scanning film.

Flatbed scanner specifications are stated **with two numbers**, like **1200x2400 dpi**. Flatbeds also usually specify a maximum resolution, like perhaps 9600 dpi. So what does all of this mean?

A scanner scans **one horizontal row of pixels** at a time, moving that scan line down the page with a carriage motor. The **smaller** dpi number is the **optical resolution** of the CCD sensor cells. A 1200 dpi scanner takes 1200 color samples per inch (creates 1200 pixels per inch) **horizontally** from the width being scanned.

The **larger** dpi number is the possible positioning of the carriage **stepping motor**. A stepping motor doesn't rotate continuously like regular motors. Instead it is pulsed to move in precise steps, rotating only a few degrees with each input power pulse. A 1200x2400 dpi scanner is geared so that each pulse of the carriage motor moves in \( \frac{1}{2400} \) inch steps **vertically**. If we scan at 300 dpi, the carriage moves eight motor steps at a time vertically, then stops and samples, and resamples the scan line to 1/4 size horizontally, to create the 300x300 dpi image requested. If scanning at say 250 dpi, it should move 2400/250 = 9.6 steps per row, but it can only move 10 steps on some rows, and 9 steps on others. Any location error will be less than half a CCD cell height, even in worst case. This is the purpose of the 2X rating of the motor. The purpose is **NOT** to scan at 2400 dpi. The motor does not contribute to optical resolution. A 1200x2400 dpi unit is a 1200 dpi scanner.
It's easy to understand the booming business that digital camera manufacturers are doing these days. The host of easy-to-use personal and business publishing applications, the dramatic expansion of the Web and its insatiable appetite for visual images, and the proliferation of inexpensive printers capable of photo-realistic output make a digital camera an enticing add-on. Those factors, combined with improving image quality and falling prices, put the digital camera on the cusp of becoming a standard peripheral for a home or business PC.

In principal, a digital camera is similar to a traditional film-based camera. There's a viewfinder to aim it, a lens to focus the image onto a light-sensitive device, some means by which several images can be stored and removed for later use, and the whole lot is fitted into a box. In a conventional camera, light-sensitive film captures images and is used to store them after chemical development. Digital photography uses a combination of advanced image sensor technology and memory storage, which allows images to be captured in a digital format that is available instantly - with no need for a "development" process.

Although the principle may be the same as a film camera, the inner workings of a digital camera are quite different, the imaging being performed either by a charge coupled device (CCD) or CMOS (complementary metal-oxide semiconductor) sensors. Each sensor element converts light into a voltage proportional to the brightness which is passed into an analogue-to-digital converter (ADC) which translates the fluctuations of the CCD into discrete binary code. The digital output of the ADC is sent to a digital signal processor (DSP) which adjusts contrast and detail, and compresses the image before sending it to the storage medium. The brighter the light, the higher the voltage and the brighter the resulting computer pixel. The more elements, the higher the resolution, and the greater the detail that can be captured.

This entire process is very environment-friendly. The CCD or CMOS sensors are fixed in place and it can go on taking photos for the lifetime of the camera. There's no need to wind film between two spools either, which helps minimise the number of moving parts.
Picture quality

The picture quality of a digital camera depends on several factors, including the optical quality of the lens and image-capture chip, compression algorithms, and other components. However, the most important determinant of image quality is the resolution of the CCD. The more elements, the higher the resolution, and thus the greater the detail that can be captured.

In 1997 the typical native resolution of consumer digital cameras was 640x480 pixels. A year later as manufacturing techniques improved and technology progressed the emergence of "megapixel" cameras meant that the same money could buy a 1024x768 or even a 1280x960 model. By early 1999, resolutions were as high as 1536x1024 and before the middle of that year the two megapixel barrier had been breached, with the arrival of 2.3 million CCDs supporting resolutions of 1800x1200. A year later the unrelenting march of the megapixels saw the three megapixel barrier breached, with the advent of 3.34 megapixel CCDs capable of delivering a maximum image size of 2048x1536 pixels. The first consumer model 4 megapixel camera appeared in mid-2001, boasting a maximum image size of 2240x1680 pixels. An 8 megapixel CCD will create images 3264 x 2448 pixels.
Features
A colour LCD panel is a feature that is present on virtually all modern digital cameras. It acts as a mini GUI, allowing the user to adjust the full range of settings offered by the camera and is an invaluable aid to previewing and arranging photos without needing to connect to a PC to do so. Typically this can be used to display a number thumbnails of the stored images simultaneously, or provide the option to view a particular image full-screen, zoom in close and, if required, delete it from memory.

Few digital cameras come with a true single-lens reflex (SLR) viewfinder, where what the user sees through the viewfinder is exactly what the camera's CCD “sees”; most have the typical compact camera separate viewfinder which sees the picture being taken from a slightly different angle and suffer the consequent problems of parallax. Most digital cameras allow the LCD to be used for composition instead of the optical viewfinder, thereby eliminating this problem. On some models this is hidden on the rear of a hinged flap that has to be folded out, rotated and then folded back into place; the screen is protected when not in use and, second, it can be flexibly positioned so as to allow the photographer to take a self-portrait or to hold the camera above their head whilst still retaining control over the framing of the shot. It also helps with one of the common problems in using an LCD viewfinder - viewing difficulty in direct sunlight. The other downside, of course, is that prolonged use causes batteries to drain quickly.

In a step designed to try to address this problem, some LCDs are provided with a power-saving skylight intended to allow it to be used without the backlight. In practice, however, this is rarely practical. If there is sufficient light to allow the skylight to work, the chances are that it will also render the LCD unusable.

Digital cameras are often described as having lenses with equivalent focal lengths to popular 35mm-camera lenses. In fact, most fixed-length lenses on digital cameras are auto-focus and have focal lengths around 8mm; these provide equivalent coverage to a standard film camera - somewhere between wide-angle and normal focal length - because the imaging CCDs are so much smaller than a frame of 35mm film. Aperture and shutter speed control are also fully automated with some cameras also allowing manual adjustment. Although optical resolution is not an aspect that features greatly in the way digital cameras are marketed, it can have a very important role in image quality. Digital camera lenses typically have an effective range of up to 20ft, an ISO equivalency of between 100 and 160 and support shutter speeds in the 1/4 of a second to 1/500th of a second range.

Digital cameras offer two distinct varieties of zoom feature: optical zoom and digital zoom. Optical zoom works in much the same way as a zoom lens on a traditional camera. Produced by the lens system, it is the magnification difference between minimum and maximum focal lengths. Importantly, in digital cameras this magnification occurs before an image is recorded in pixels. Digital zoom, on the other hand, is arguably little more than a marketing gimmick.

By the early 2000s many digital cameras came equipped with motorised optical zoom lenses which provided an effective range from wide-angle to telephoto. These generally come in a range between 3x and 10x, but it can be higher. The “times" notation can be confusing, with "3x", for example, having a different precise meaning for different cameras. This is because the actual focal length of a digital camera relates to the size of its sensor.
Digital camera specifications therefore generally also cite a "35mm equivalent" lens rating. A 3x zoom lens is the standard offering and generally implies an "equivalent" focal length of some range between 35mm and 140mm. Some cameras have a gradual zoom action across the total focal range, others provide two or three predefined settings.

Digital zoom is nothing more than the cropping of the middle of an image by a digital camera's software. When an image that has been digitally zoomed 2x is reproduced, either on a display monitor or by being printed, it will effectively be viewed at half its original resolution. A more sophisticated form of digital zoom uses the digital camera's software to interpolate the cropped image back to its original resolution. In this event, fewer of the original pixels are used to represent the enlarged image, which will appear less sharp as a result. Some digital cameras provide a digital zoom feature as an alternative to an true optical zoom, others provide it as an additional feature.

For close-up work, a macro function is often provided, allowing photos to be taken at a distance as close as 3cm but more typically supporting a focal range of around 10-50cm. Some digital cameras even have swivelling lens units, capable of rotating through 270 degrees and allowing a view of the LCD viewfinder panel regardless of the angle of the lens itself.

Every digital camera has a fully automatic mode metering that allows a user to simply point and shoot. However, in common with traditional film cameras, they also offer a number of different ways of controlling the exposure of an image. A good exposure will result in an image that has balanced contrast and brightness, with no areas that are too bright and washed out or too dark which also creates loss of detail. Center weighted metering is the system used by many digital cameras to measure the correct exposure. With this system, the camera measures the amount of light mostly around the centre area of the lens and less towards the edges. For many situations this works well, but in some lighting situations, centre weighted metering can produce poorly exposed photos. If the scene to be photographed has light areas and dark areas, for example in the shade of trees on bright sunny days with lots of sunlight and shadowed areas, centre weighed metering will often either overexpose the bright sections, or underexpose the dark sections. Some digital cameras offer matrix type metering systems, which break the scene into several areas and measures each individual area's exposure. This results in an image with a balanced exposure throughout. Spot metering is another option included on some digital camera models. This measures the exposure at a small, precise portion in the centre of the lens, allowing the user to ensure perfect exposure on a particular section of the scene.

Programmed auto-exposure modes keep the basic exposure settings automatic while providing manual access to other camera settings. Some offer aperture- and shutter-priority modes which allow the user to set the f-stop or shutter speed, and then automatically calculate the other settings needed to expose an image correctly.

Some cameras provide a manual exposure mode, allowing the photographer a significant degree of artistic licence. Typically, four parameters can be set in this mode: white balance, exposure compensation, flash power and flash sync. Different types of light (outdoor, fluorescent, and so on) will have an impact on the colours in images. White balance provides a means to correct for the effect of the lighting conditions, such as sunny, cloudy, incandescent or fluorescent. Exposure compensation alters the overall exposure of the shot
relative to the metered "ideal" exposure. This feature is similar to that a SLR cameras, allowing a shot to be intentionally under- or over-exposed to achieve a particular effect. A flash power setting allows the strength of the flash to be incrementally altered and a flash sync setting allows use of the flash to be forced, regardless of the camera's other settings.

Some cameras offer what is referred to as "automatic exposure bracketing". With this, several frames are shot when the shutter is released, each at a different exposure setting. The exposure that gave the best result can then be selected.

Most digital cameras offer a number of image exposure timing options. One of the most popular is a burst mode that allows a number of exposures to be taken with a single press of the shutter. The speed and number of sequential shots that can be captured in a burst is dependent on the amount of internal memory the camera possesses, the image size selected and the degree of compression applied to the photos. Cameras with fast burst rates - specified as a fps rate - generally have a large amount of "buffer memory", which is used as a temporarily store prior an image being processed and written to the camera's primary image storage medium. By the early 2000s, the capability to shoot up to 15 shots in a burst at rates between 2 and 6 fps was fairly typical.

Also common is time-lapse, which delays multi-picture capture over preselected interval. Other examples are the ability for four consecutive shots to each use only a quarter of the available CCD array, resulting in a single frame with four separate images stored on it and to take multiple exposures at a preset delay interval, tiling the resulting images in a single frame.

Features allowing a variety image effects are becoming increasingly common. For example, a user may have the option to select between monochrome, negative and sepia modes. Apart from their use for artistic effect, the monochrome mode is useful for capturing images of documents for subsequent optical character recognition (OCR). Some digital cameras also provide a "sports" mode - which adds sharpness to the captured images of moving objects - and a "night shooting" mode which allows for long exposures.

Panoramic modes differ in their degree of complexity. At the simpler end of the spectrum is the option for a letterbox aspect image that simply trims off the top and the bottom edges of a standard image - taking up less storage space in the process. More esoteric is the ability to produce pseudo-panoramic shots by capturing a series of images and then combining them into a single panoramic landscape using special-purpose software.

A self-timer is a common feature, typically providing a 10-second delay between the time the shutter is activated and when the picture is taken and all modern day digital cameras have a built-in automatic flash, with a manual override option. The best have a working range of up to 12ft and provide a number of different modes, such as auto lowlight and backlight flash, fill flash for bright lighting shadow reduction, force-off for indoor and mood photography and red-eye reduction. Red-eye is caused by light reflected back from the retina, which is covered in blood vessels. One system works by shining an amber light at the subject for a second before the main burst of light, causing the pupil to shrink so that the amount of red light reflected back is reduced.
Another feature commonly available with film cameras that is available on their digital counterparts is the ability to watermark a picture with a date and time, or indeed some other chosen text. And that's not all. The recent innovation of built-in microphones provides for sound annotation, in standard WAV format. After recording, this sound can be sent to an external device for playback, or played back on headphones using an ear socket. Some cameras even offer an audio made that effectively allows it to be used as a voice recorder.

A couple of other features which demonstrate the digital camera's close coupling with other aspects of PC technology are a function that allows thumbnail images to be emailed directly by camera-resident software and the ability to capture short video clips that can be stored in MPEG-1 format. Some cameras record silent video only and limit the length of the clips; others sound with the video and allow the clip to be as long as the camera is capable of saving to its storage media.

Borrowing from technology developed for their video camcorder brethren, some digital cameras feature image stabilisation systems. This is particularly useful when used in conjunction with high powered zoom lenses, when it can be very difficult to keep the camera still enough to create a clear image, especially in low light situations and when using a slow shutter speed. Image stabilisation is employed to help overcome the effects small movements of the camera.
Storyboarding

A storyboard may be generated from a media presentation or created prior to the development of the presentation as a plan. Storyboards consist of a series of frames, each representing a different action or screen image. A storyboard may be hand drawn or computer generated.

A storyboard is a graphical planning and documentation tool when designing and making a multimedia information system. It includes:

- each screen and the specific media types (text, hypertext, graphics, audio, video) of the multimedia system
- navigation paths
- information about the information

Storyboards can be constructed using a number of different layouts. Below is an example of a linear layout. This layout is used for presentations that follow a sequence, for example, a film.

![Linear Diagram]

A hierarchical layout is used to define a series of levels and sub levels. This approach is referred to as top down design.

![Hierarchical Diagram]
A non-linear layout has no particular structure; the user moves between different sections in any direction.

A combination layout uses a combination of the layouts described above. In the example below, a combination of hierarchical and linear layouts is used.
Image creation/editing

Image editing encompasses the processes of altering images, whether they be digital photographs, traditional analog photographs, or illustrations. Traditional analog image editing is known as photo retouching, using tools such as an airbrush to modify photographs, or editing illustrations with any traditional art medium. Graphic software programs, which can be broadly grouped into vector graphics editors, raster graphics editors, and 3d modelers, are the primary tools with which a user may manipulate, enhance, and transform images. Many image editing programs are also used to render or create computer art from scratch.

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Basics of image editing

Raster images are stored in a computer in the form of a grid of picture elements, or pixels. These pixels contain the image's color and brightness information. Image editors can change the pixels to enhance the image in many ways. The pixels can be changed as a group, or individually, by the sophisticated algorithms within the image editors. The domain of this article primarily refers to bitmap graphics editors, which are often used to alter photographs and other raster graphics. However, vector graphics software, such as Adobe Illustrator or Inkscape, are used to create and modify vector images, which are stored as descriptions of lines, Bézier splines, and text instead of pixels. It is easier to rasterize a vector image than to vectorize a raster image- how to go about vectorizing a raster image is the focus of much research in the field of computer vision. People like vector images because they are easy to modify, containing descriptions of the shapes in them for easy rearrangement, as well as scalable, being rasterizable at any resolution- to rasterize a vector image is simply to render it, while scaling a raster image up involves guessing at data that isn't there (see aliasing and other articles on information theory for more), and even scaling a raster image down involves guessing unless the scaling factor is an integer.

Editing programs

Due to the popularity of digital cameras, image editing programs are readily available. Minimal programs, that perform such operations as rotating and cropping are often provided within the digital camera itself, while others are returned to the user on a compact disc (CD) when images are processed at a discount store. The more powerful programs contain functionality to perform a large variety of advanced image manipulations. Popular raster-based digital image editors include Adobe Photoshop, GIMP, Corel Photo-Paint, Paint Shop Pro and Paint.NET.

Digital data compression

Many image file formats use data compression to reduce file size and save storage space. Digital compression of images may take place in the camera, or can be done in the computer with the image editor. When images are stored in JPEG format, compression has already taken place. Both cameras and computer programs allow the user to set the level of compression.

Some compression algorithms, such as those used in PNG file format, are lossless, which means no information is lost when the file is saved. The JPEG file format uses a lossy compression algorithm- The greater the compression, the more information is lost, ultimately reducing image quality or detail. JPEG uses knowledge of the way the brain and eyes perceive color to make this loss of detail less noticeable.
Image editor features

Listed below are some of the most used capabilities of the better graphic manipulation programs. The list is by no means all inclusive. There are a myriad of choices associated with the application of most of these features.

Selection

One of the prerequisites for many of the applications mentioned below is a method of selecting part(s) of an image, thus applying a change selectively without affecting the entire picture. Most graphics programs have several means of accomplishing this, such as a marquee tool, lasso, vector-based pen tools as well as more advanced facilities such as edge detection, masking, alpha compositing, and color and channel-based extraction.

Layers

Another feature common to many graphics applications is that of Layers, which are analogous to sheets of transparent acetate (each containing separate elements that make up a combined picture), stacked on top of each other, each capable of being individually positioned, altered and blended with the layers below, without affecting any of the elements on the other layers. This is a fundamental workflow which has become the norm for the majority of programs on the market today, and enables maximum flexibility for the user whilst maintaining non-destructive editing principles and ease of use.

Image size alteration

Image editors can resize images in a process often called image scaling, making them larger, or smaller. High image resolution cameras can produce large images which are often reduced in size for Internet use. Image editor programs use a mathematical process called resampling to calculate new pixel values whose spacing is larger or smaller than the original pixel values. Images for Internet use are kept small, say 640 x 480 pixels which would equal 0.3 megapixels.
Cropping an image

Digital editors are used to crop images. Cropping creates a new image by selecting a desired rectangular portion from the image being cropped. The unwanted part of the image is discarded. Image cropping does not reduce the resolution of the area cropped. Best results are obtained when the original image has a high resolution. A primary reason for cropping is to improve the image composition in the new image.

![Uncropped image from camera](image1) ![Lilly cropped from larger image](image2)

Histogram

Image editors have provisions to create an image histogram of the image being edited. The histogram plots the number of pixels in the image (vertical axis) with a particular brightness value (horizontal axis). Algorithms in the digital editor allow the user to visually adjust the brightness value of each pixel and to dynamically display the results as adjustments are made. Improvements in picture brightness and contrast can thus be obtained.

![Sunflower image](image3) ![Histogram of Sunflower image](image4)
Noise removal

Image editors may feature a number of algorithms which can add or remove noise in an image. JPEG artifacts can be removed; dust and scratches can be removed and an image can be de-speckled. Noise removal merely estimates the state of the scene without the noise and is not a substitute for obtaining a "cleaner" image. Excessive noise reduction leads to a loss of detail, and its application is hence subject to a trade-off between the undesirability of the noise itself and that of the reduction artifacts.

Noise tends to invade images when pictures are taken in low light settings. A new picture can be given an 'antiquated' effect by adding uniform monochrome noise.

Removal of unwanted elements

Most image editors can be used to remove unwanted branches, etc, using a "clone" tool. Removing these distracting elements draws focus to the subject, improving overall composition.

Notice the branch in the original The eye is drawn to the center of the globe
Selective color change

Some image editors have color swapping abilities to selectively change the color of specific items in an image, given that the selected items are within a specific color range.

An example of selective color change, the original is on the left.

The original car is on the right.
Image orientation

Image orientation: left–original; center–30° CCW rotation; right–flopped.

Image editors are capable of altering an image to be rotated in any direction and to any degree. Mirror images can be created and images can be horizontally flipped or vertically flopped. A small rotation of several degrees is often enough to level the horizon, correct verticality (of a building, for example), or both. Rotated images usually require cropping afterwards, in order to remove the resulting gaps at the image edges.

Perspective correction and distortion

Perspective correction: left–original, uncorrected
right–perspective distortion removed

Some image editors allow the user to distort (or “transform”) the shape of an image. While this might also be useful for special effects, it is the preferred method of correcting the typical perspective distortion which results from photographs being taken at an oblique angle to a rectilinear subject. Care is needed while performing this task, as the image is reprocessed using interpolation of adjacent pixels, which may reduce overall image definition. The effect mimics the use of a perspective correction lens, which achieves a similar correction in-camera without loss of definition.
Lens correction

Photo manipulation packages have functions to correct images for various lens distortions including pincushion, fisheye and barrel distortions. The corrections are in most cases subtle, but can improve the appearance of some photographs.

Sharpening and softening images

Graphics programs can be used to both sharpen and blur images in a number of ways, such as unsharp masking or deconvolution. Portraits often appear more pleasing when selectively softened (particularly the skin and the background) to better make the subject stand out. This can be achieved with a camera by using a large aperture, or in the image editor by making a selection and then blurring it. Edge enhancement is an extremely common technique used to make images appear sharper, although purists frown on the result as appearing unnatural.

Selecting and merging of images

Original Image

Background Image

Merged Image
Many graphics applications are capable of merging one or more individual images into a single file. The orientation and placement of each image can be controlled. The two images shown here were once individual studio portraits.

When selecting a raster image that is not rectangular, it requires separating the edges from the background, also known as silhouetting. This is the digital version of cutting out the image. Clipping paths may be used to add silhouetted images to vector graphics or page layout files that retain vector data. Alpha compositing, allows for soft translucent edges when selecting images. There are a number of ways to silhouette an image with soft edges including selecting the image or its background by sampling similar colors, selecting the edges by raster tracing, or converting a clipping path to a raster selection. Once the image is selected, it may be copied and pasted into another section of the same file, or into a separate file. The selection may also be saved in what is known as an alpha channel.

A popular way to create a composite image like this one is to use transparent layers. In this case, the "background image" shown at left was placed as the bottom layer. The layer marked "Original Image" at left was then added as a second layer in a multi-layer document. Using an image layer mask, all but the girl are hidden from the layer, giving the impression that she has been added to the background layer. Performing a merge in this manner preserves all of the pixel data on both layers to more easily enable future changes (such as adding the second individual) in the new merged image.

**Slicing of images**

A more recent tool in digital image editing software is the image slicer. Parts of images for graphical user interfaces or web pages are easily sliced, labeled and saved separately from whole images so the parts can be handled individually by the display medium. This is useful to allow dynamic swapping via interactivity or animating parts of an image in the final presentation.
Special effects

An example of some special effects that can be added to a picture.

Image editors usually have a list of special effects that can create unusual results. Images may be skewed and distorted in various ways. Scores of special effects can be applied to an image which include various forms of distortion, artistic effects, geometric transforms and texture effects, or combinations thereof.

Change color depth

An example of converting an image from color to grayscale.

It is possible, using software, to change the color depth of images. Common color depths are 2, 4, 16, 256, 65.5 thousand and 16.7 million colors. The JPEG and PNG image formats are capable of storing 16.7 million colors (equal to 256 luminance values per color channel). In addition, grayscale images of 8 bits or less can be created, usually via conversion and down-sampling from a full color image.
Contrast change and brightening

An example of contrast correction. Left side of the image is untouched.

Image editors have provisions to change the contrast of images and brighten or darken the image. Underexposed images can be often be improved by using this feature. Recent advances have allowed more intelligent exposure correction whereby only pixels below a particular luminosity threshold are brightened, thereby brightening underexposed shadows without affecting the rest of the image.

Color adjustments

An example of color adjustment using Photoshop

The color of images can be altered in a variety of ways. Colors can be faded in and out, and tones can be changed using curves or other tools. The color balance can be improved, which is important if the picture was shot indoors with daylight film, or shot on a camera that with an incorrectly adjusted white balance. Special effects, like sepia and grayscale can be added to an image. In addition, more complicated procedures such as the mixing of color channels are possible using more advanced graphics editors.

The red-eye effect, which occurs when flash photos are taken when the pupil is too widely open (so that light from the flash that passes into the eye through the pupil reflects off the fundus at the back of the eyeball), can also be eliminated at this stage.
Controlling the print size and quality of digital images requires an understanding of the pixels-per-inch (ppi) variable that is stored in the image file and sometimes used to control the size of the printed image. Within the Image Size dialog (as it is called in Photoshop), the image editor allows the user to manipulate both pixel dimensions and the size of the image on the printed document. These parameters work together to produce a printed image of the desired size and quality. Pixels per inch of the image, pixel per inch of the computer monitor, and dots per inch on the printed document are related, but in use are very different. The Image Size dialog can be used as an image calculator of sorts. For example, a 1600 x 1200 image with a ppi of 200 will produce a printed image of 8 x 6 inches. The same image with a ppi of 400 will produce a printed image of 4 x 3 inches. Change the ppi to 800, and the same image now prints out at 2 x 1.5 inches. All three printed images contain the same data (1600 x 1200 pixels) but the pixels are closer together on the smaller prints, so the smaller images will potentially look sharp when the larger ones do not. The quality of the image will also depend on the capability of the printer.
Authoring

Authoring is the process of combining materials such as video, graphics, sound, animation, documents, and files into a format suitable for viewing on the appropriate device. Such devices include but are not limited to DVD players, computers, and the Internet. Often authoring involves the creation of an interface, allowing the user to navigate and access the different assets or files easily and conveniently. In the case of DVD authoring, this interface consists of a menu or menus with play and chapter (scene) buttons.
Publishing

The authored products are delivered in a range of different media formats. Your product can be developed in a specific format decided by a client, or you could be developing a product you are hoping will have maximum market penetration. The final decision of the choice of published media is the target platform where the product is to be used. In some cases, the platform on which the product is developed will differ from the target platform. Authoring packages provide tools to prepare the developed product, for delivery on the production platform. The authoring process does not need to stop there. Depending on the product, it may be necessary to perform some form of rendering to create the final distributed media. This would be the case with video, or products distributed on variable format CD-ROMs.

<table>
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<tr>
<th>Distribution media</th>
<th>Production process</th>
<th>Publishing process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk</td>
<td>Authoring software builds interactive sequences of media. Software includes: Macromedia Director.</td>
<td>Product is saved as a computer package, on a removable disk. The package includes the authored product and any programs necessary to deliver the product. The programs are specific to the target platform and are compiled into compatible format. All files are packaged together and are installed on the target disk. Installation programs are used to ensure files are copied and registered appropriately for the target platform.</td>
</tr>
<tr>
<td>Internet</td>
<td>Authoring software builds sequences of web pages linked to media files. Software includes: Microsoft Front Page, Macromedia Dreamweaver.</td>
<td>Documents and programs are uploaded to web sites. Files are copied to appropriate directories on the server. Programs are prepared to run on the servers operating system.</td>
</tr>
<tr>
<td>Video/Film</td>
<td>Authoring software builds a non-interactive sequence of audio and video media. Software includes: Adobe Photoshop.</td>
<td>The product is stored in a digital or analogue format. Digital is distributed as a file; however, an analogue term is used to refer to videotape. The developed product is transferred to tape using hardware which interfaces the computer and the video recorders.</td>
</tr>
<tr>
<td>ROM</td>
<td>Authoring software creates very efficient program files, integrating optimised media files. Software includes: C++ and Visual Basic</td>
<td>Programs are recorded onto an erasable ROM chip. This process is known as burning, as the contents of the chip are retained when the delivery platform is turned off. Chips are erased either electronically or exposing the chip to light. This process is cheaper than actually designing and producing a chip with the program 'hard wired'.</td>
</tr>
</tbody>
</table>
Originally multimedia productions were prepared to run on separate target delivery platforms. A product designed and developed for a Mac would only run on a Mac. The same applied to the PC. As cross-platform development environments evolved authoring software became available on both Macs and PCs. The native file for the authored product was in the same format for both platforms. A product would be authored on one platform then copied to the other, then published on both. The Internet extends this principle by delivering a file in a common format, and installed on each platform is a program, that interprets that file and creates a use interface. This program, of course is the web browser, and the common file format is HTML (HyperText Markup Language). An HTML file contains instructions to the browser on how a screen is constructed, the appearance of text, the placing and rendering of multimedia elements and processing commands. Web pages are essentially designed to display content, and allow the user to jump to other pages.

To create more media rich products, multimedia products can be downloaded as separate files. These files are then run by software installed on the delivery platform. Java applets are interpreted by an interpreter in the browser, and hence are cross platform. Shockwave files are examples of products created with Macromedia development tools such as Flash or Director, and then optimised for delivery over the web; to run these requires downloading and installing a player. If you are running a browser, on a Microsoft platform you can use ActiveX. These are actual programs installed on the target computer, and can provide very fast and highly functional products. The trade-off is exactly the same as for media files. Large product files downloaded over a slow connection with low bandwidth, can leave the user waiting for a production to start. The extension to this will be the appearance of more products that support streaming of program files.
<table>
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<tr>
<th>Issues</th>
<th>Description</th>
<th>Recommendation</th>
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<tbody>
<tr>
<td>Fonts</td>
<td>Installed fonts differ from computer to computer, depending on the software installed on the target platform</td>
<td>Use fonts common on each platform. On Macs use Helvetica or Times Roman. On PCs Arial or Times New Roman. When using fancy fonts consider saving as a graphic</td>
</tr>
<tr>
<td>Colour</td>
<td>There are still many users who view web pages with a video display capability of 256 colours only</td>
<td>Use web safe colours for visual presentation. Palettes uses only 216 colours which can be rendered by all browsers</td>
</tr>
<tr>
<td>Media integration browser rendered</td>
<td>The browser is restricted to the number of media types it can render</td>
<td>Use only JPEG, GIF or PNG file formats for graphics; use only WAV audio files for PC and AIFF files for MAC</td>
</tr>
<tr>
<td>Media integration downloaded</td>
<td>Tags in HTML allow the downloading of media files. The browser cannot render these files and will pass them onto any programs associated with them</td>
<td>Media files should be small, the file is downloaded to the computer's memory before it is played</td>
</tr>
<tr>
<td>Media integration streaming</td>
<td>If an HTML file contains a reference to a streaming media file format, a player is loaded and the file is played as it is being downloaded</td>
<td>Install QuickTime or Real One Players on delivery platform</td>
</tr>
<tr>
<td>Scripting languages</td>
<td>Scripting languages interpreted by the browser are restricted to Javascript or VBScript. Both languages allow the developer to control objects in a web page using an extension to HTML known a DHTML (Dynamic HTML). The interpreters for these languages are built into the browser</td>
<td>Javascript is traditionally used for browser script. However, VBScript is well supported, especially in browsers such as Microsoft Internet Explorer</td>
</tr>
<tr>
<td>Program objects</td>
<td>Although scripting languages allow the developer to create multimedia products using just web pages, they are limited. Products with complex interactions or animation store their instructions in a separate file which is downloaded with the web page. The program files could be Java applets, shockwave presentations, or activeX objects</td>
<td>Java applets are cross platform and are interpreted by the browser. Shockwave presentations need to have a run-time module, but are easier to develop than Java applets. ActiveX objects are Microsoft platform specific programs, and work to some degree across platforms</td>
</tr>
</tbody>
</table>
Copyright

What is copyright?

Copyright protects the original expression of ideas, not the ideas themselves. It is free and automatically safeguards your original works of art and literature, music, films, sound recording, broadcasts and computer programs from copying and certain other uses. Copyright is not registered in Australia.

Material is protected from the time it is first written down, painted or drawn, filmed or taped. Copyright material will also enjoy protection under the laws of other countries who are signatories to the international treaties, of which Australia is a member.

Copyright protection is provided under the Copyright Act 1968 and gives exclusive rights to license others in regard to copying the work, performing it in public, broadcasting it, publishing it and making an adaptation of the work. Rights vary according to the nature of the work. Those for artistic works, for instance, are different to those for literary and musical works.

Although making copies of copyright material can infringe exclusive rights, a certain amount of copying is permissible under the fair dealing provisions of the legislation.

Copyright doesn't protect you against independent creation of a similar work. Legal actions against infringement are complicated by the fact that a number of different copyrights may exist in some works - particularly films, broadcasts and multimedia products.

The “fair dealing” exceptions to infringement

There is no general exception for using copyright material simply because you think it is fair or because you are not making a profit. The copyright act allows you to use copyright material without permission if your use is a “fair dealing” for one of the following purposes:

- research or study;
- criticism or review;
- parody or satire;
- reporting news; or
- professional advice by a lawyer, patent attorney or trade marks attorney.

Penalties for breaches

Generally, copyright is infringed if copyright material is used without permission, in one of the ways exclusively reserved to the copyright owner.

- There are some situations in which people can use copyright material without permission, either for free or on other terms.
- A copyright owner is entitled to commence a civil action in court against someone who has infringed his or her copyright, and may be entitled to various remedies.
- Some infringements of copyright – generally those that involve a commercial element – are also criminal offences, and various penalties can be imposed if someone is convicted of a copyright offence or issued with an infringement notice.
File Formats Glossary

AU
An audio format commonly used for posting sound clips on the Internet. AU files can be played back on Windows, Macintosh, and other operating systems.

AVCHD
A high-definition digital video format that can record in 1080i and 720p and still maintain a reasonably small file size. AVCHD files are based on the MPEG4 codec. The advent of high-definition (HD) televisions and displays spurred the development of this format, which uses the same resolution as HDTV signals. AVCHD video files can also be burned to Blu-ray Discs™, and played in compatible devices, such as Blu-ray Disc players and the Sony PlayStation®3.

AVI (Audio/Video Interleaved)
A file format for storing and playing back movie clips with sound on Windows-based PCs. An AVI file is organized into alternating (“interleaved”) chunks of audio and video data. AVI is a container format, meaning that it specifies how the data will be organized, but is not itself a form of audio or video compression.

AVI is the type of file that’s created when DV clips are imported from a digital camcorder to a PC. (These clips are often referred to as “DV-AVIs” because they contain full-quality digital video content.)

Bitrate
With audio compression, the average amount of data required to store one second of music (expressed in kilobits per second, or Kbps). Some codecs like MP3, WMA, and AAC allow files to be encoded at different bitrates. Generally, as bitrate decreases, so does the sound quality of the resulting file, as well as the amount of memory required to store it.

BMP (Windows Bitmap Image)
A standard format used for storing images on Windows-based PCs. BMP images can either be compressed or uncompressed. This type of file also sometimes appears with the ".DIB" extension.

Codec
A codec is a way of compressing and decompressing digital files. Each codec uses a slightly different set of algorithms to accomplish this.
Container format

A container format is one that holds different kinds of data within its file. Container formats, such as RealAudio and TIFF, are gaining in popularity because of their multimedia applications, as well as their cross-platform compatibility. For example, a single container file can hold chapter information, hyperlinks and subtitles, as well as different kinds of codecs that enable various types of players to read the file.

DV (Digital Video)

DV is the format used by many digital camcorders, usually on Mini DV cassettes. Though the DV format employs a form of lossy video compression (applied in real-time as you record with your camera), it's still memory-intensive. When transferred to a computer, a DV clip requires roughly 1 GB of storage per 5 minutes of video. (Clips are usually stored on the computer as QuickTime or .AVI files.)

Despite its use of compression, DV can provide a clean image with up to 520 lines of resolution. DV uses a type of compression known as "intraframe"—that is, it encodes video at the full standard frame rate of 30 frames per second. This allows frame-by-frame editing. In contrast, video codecs like MPEG1 or MPEG2 tend to handle a video sequence by reducing the number of full frames per second and encoding the differences between frames, making precise editing more difficult. These are known as "interframe" forms of compression.

DivX

DivX was developed by DivX, Inc., to compress a great deal of video content into relatively small files and still retain reasonably good image quality when played back. DivX is based on MPEG-4, and is a popular choice for sending video files over the Internet.

GIF (Graphic Interchange Format)

A format for storing digital images, commonly used for bullets, icons, and other graphics on the Web. The GIF format is limited to 256 colors, so it's not as commonly used as JPEG for storing digital photos. A single GIF file can combine several frames together for basic animated motion.

JPEG

Named after the Joint Photographic Experts Group, JPEG is a lossy codec for storing and transferring full-color digital images that's often used to post photography and artwork on the Web. JPEG compression takes advantage of the human eye's inability to see minute color changes, removing portions of data from the original picture file. When creating a JPEG file, varying amounts of compression can be selected, depending on the desired file size and image quality.

A form of this codec known as Motion JPEG is used by some digital cameras and camcorders for storing video clips of relatively small file size. With Motion JPEG, each frame of video is captured separately and reduced in size using JPEG compression.
**Lossless data compression**

As the name implies, lossless compression retains all of the data of the original file as it's converted to a smaller file size. When a lossless file such as a TIFF is opened, algorithms restore all compressed information, creating a duplicate of the source file. Lossless compression is generally preferred for creating high-quality or professional-grade audio and video files where it's important to retain fine detail.

**Lossy data compression**

With this kind of compression, some of the source file's information is discarded to conserve space. When the file is decompressed, this information is reconstructed through algorithms, usually resulting in some loss of sound quality or image detail when compared to the original. Generally, the higher the resolution of the compressing file, the less the degradation. An MP3 file with a resolution of 256 Kbps, for example, tends to sound more like the source file than one made at 64 Kbps.

**MIDI (Musical Instrument Digital Interface)**

A MIDI file doesn't contain actual audio data, but rather contains commands that let MIDI-capable synthesizers re-create a specific musical passage. The MIDI protocol has been used for years as a way for electronic musical instruments (like digital keyboards and sequencers) to communicate with each other.

Computer sound cards typically feature the ability to interpret MIDI files into music. Since they don't actually contain the music itself, but rather the commands used to re-create music, MIDI files are a lot smaller than audio files like MP3s, WMAs, or WAVs. MIDI files are small and manageable enough that it's not uncommon to find them embedded in web pages, adding a sonic element to the surfing experience. They usually appear with the "_.MID" filename extension.

**MPEG**

MPEG stands for Moving Picture Experts Group — a committee that sets international standards for the digital encoding of movies and sound. There are several audio/video formats which bear this group's name. In addition to their popularity on the Internet, several MPEG formats are used with different kinds of A/V gear:

- **MPEG1.** This format is often used in digital cameras and camcorders to capture small, easily transferable video clips. It's also the compression format used to create Video CDs, and commonly used for posting clips on the Internet. The well-known MP3 audio format (see definition below) is part of the MPEG1 codec.

- **MPEG2.** Commercially produced DVD movies, home-recorded DVD discs, and most digital satellite TV broadcasts employ MPEG2 video compression to deliver their high-quality picture. MPEG2 is also the form of lossy compression used by TiVo-based hard disk video recorders. It can rival the DV format when it comes to picture quality. Because MPEG2 is a "heavier" form of compression that removes a larger portion of the original video signal than DV, however, it's more difficult to edit with precision. The MPEG2 codec allows for selectable amounts of compression to be applied, which is how home DVD recorders and
hard disk video recorders can offer a range of recording speeds. MPEG2 is considered a container format.

**MPEG4.** A flexible MPEG container format used for both streaming and downloadable Web content. It's the video format employed by a growing number of camcorders and cameras.

**MP3 (MPEG1, Audio Layer 3)**

The most popular codec for storing and transferring music. Though it employs a lossy compression system which removes frequencies judged to be essentially inaudible, MP3 still manages to deliver near-CD sound quality in a file that's only about a tenth or twelfth the size of a corresponding uncompressed WAV file. When creating an MP3 file, you can select varying amounts of compression depending on the desired file size and sound quality. For more info, see our article on the MP3 format.

**QuickTime**

QuickTime is a file format for storing and playing back movies with sound. Though developed and supported primarily by Apple, Inc., this flexible format isn't limited to Macintosh operating systems — it's also commonly used in Windows systems and other types of computing platforms. In Windows, QuickTime files usually appear with the ".MOV" filename extension.

**RAW**

An image file of minimally processed data received from a digital camera. Most camera manufacturers have their own proprietary version of the RAW image format, and their own file suffixes. Canon, for example, uses ".crw" or ".cr2" for their version of RAW. Nikon's RAW files end in ".nef," while Sony uses " .arw" and ".srf" suffixes.

Professionals prefer shooting in RAW because the additional information these large files contain allows greater flexibility in post-production editing. Because the image is basically unprocessed (as compared to a JPEG image), RAW files can retain very subtle color variations and fine detail. Color changes, contrast adjustments, and other manipulations of a RAW image yield significantly fewer digital artifacts than the same changes made to a comparable JPEG file.

**RealMedia**

One of the most popular formats for streaming content on the Internet, RealMedia includes the RealAudio codec for sound clips and RealVideo codec for movies. RealAudio and RealVideo files are often given the common RealMedia ".RM" file extension. RealMedia is a container format that's often heavily compressed for streaming over dial-up Internet connections. RealMedia variable bitrate (RMVB) has been developed for VBR streaming files.
TIFF (Tag Image File Format)

TIFF is a flexible container format for digital still images, commonly used in desktop publishing. TIFF images can incorporate various forms of compression (like JPEG), or can be uncompressed. Some digital cameras offer a special TIFF mode for capturing uncompressed photos; however, these files require many times more storage space than JPEGs, and can quickly fill up your camera's available memory.

WAV

A standard audio format for Windows operating systems, often used for storing high-quality, uncompressed sound. WAV files can contain CD-quality (44.1 KHz/16-bit) audio signals. However, CD-quality WAV files require relatively large amounts of memory — roughly 10 MB per minute of music. WAV is a container format.

WMA (Windows Media Audio)

Developed by Microsoft, Windows Media Audio is one of today's most pervasive Internet audio formats. Though not as popular as MP3, proponents of lossy WMA claim that it can outperform MP3 in the area of sound quality, particularly with files encoded at lower bitrates such as 64 or 96 Kbps. This performance advantage makes it handy for applications like portable digital audio players, where total play time is limited by a finite amount of internal memory.

The Windows Media Audio format features built-in copy protection abilities, unlike MP3. Windows Vista, Microsoft's current flagship operating system software, contains native support for WMA encoding, enabling users to create their own WMA music files.

WMV (Windows Media Video)

Microsoft's proprietary lossy compression format for motion video. Windows Media Video is used for both streaming and downloading content via the Internet. Microsoft's Windows Media Player, an application bundled with Windows Vista operating systems, lets you play back and manage a range of audio and video file types, including WMA and WMV.

Xvid

Xvid is an open-source lossy video codec based on MPEG-4. It was developed in response to DivX, and received its name from the backwards spelling of DivX. Xvid compresses a great deal of video content into relatively small files, and retains a reasonably good video resolution. It can be used with several different operating systems, and is a popular choice for transferring video over the Internet.
Image Formats

Image file formats are standardized means of organising and storing images. This entry is about digital image formats used to store photographic and other images; (for disk-image file formats see Disk image). Image files are composed of either pixel or vector (geometric) data that are rasterized to pixels when displayed (with few exceptions) in a vector graphic display. The pixels that compose an image are ordered as a grid (columns and rows); each pixel consists of numbers representing magnitudes of brightness and colour.

Image file size—expressed as the number of bytes—increases with the number of pixels composing an image, and the colour depth of the pixels. The greater the number of rows and columns, the greater the image resolution, and the larger the file. Also, each pixel of an image increases in size when its colour depth increases—an 8-bit pixel (1 byte) stores 256 colours, a 24-bit pixel (3 bytes) stores 16 million colors, the latter known as truecolor.

Image compression uses algorithms to decrease the size of a file. High resolution cameras produce large image files, ranging from hundreds of kilobytes to megabytes, per the camera's resolution and the image-storage format capacity. High resolution digital cameras record 8 megapixel (1MP = 1,000,000 pixels / 1 million) images, or more, in truecolor. For example, an image recorded by an 8 MP camera; since each pixel uses 3 bytes to record truecolor, the uncompressed image would occupy 24,000,000 bytes of memory—a great amount of digital storage for one image, given that cameras must record and store many images to be practical. Faced with large file sizes, both within the camera and a storage disc, image file formats were developed to store such large images. An overview of the major graphic file formats follows below.

Image file compression
There are two types of image file compression algorithms: lossless and lossy.

Lossless compression
Lossless compression algorithms reduce file size without losing image quality, though they are not compressed as small a file as a lossy compression file. When image quality is valued above file size, lossless algorithms are typically chosen.

Lossy compression
Lossy compression algorithms take advantage of the inherent limitations of the human eye and discard invisible information. Most lossy compression algorithms allow for variable quality levels (compression) and as these levels are increased, file size is reduced. At the highest compression levels, image deterioration becomes noticeable as “compression artifacting".
Major graphic file formats

There are many graphic file formats, if we include the proprietary types. The PNG, JPEG, and GIF formats are most often used to display images on the Internet. These graphic formats are listed and briefly described below, separated into the two main families of graphics: raster and vector.

Raster formats

These formats store images as bitmaps (also known as pixmaps).

JPEG (Joint Photographic Experts Group) files are (in most cases) a lossy format; the DOS filename extension is JPG (other OS might use JPEG). Nearly every digital camera can save images in the JPEG format, which supports 8 bits per color (red, green, blue) for a 24-bit total, producing relatively small files. When not too great, the compression does not noticeably detract from the image's quality, but JPEG files suffer generational degradation when repeatedly edited and saved. Photographic images may be better stored in a lossless non-JPEG format if they will be re-edited, or if small “artefacts” (blemishes caused by the JPEG's compression algorithm) are unacceptable. The JPEG format also is used as the image compression algorithm in many Adobe PDF files.

TIFF

The TIFF (Tagged Image File Format) is a flexible format that normally saves 8 bits or 16 bits per color (red, green, blue) for 24-bit and 48-bit totals, respectively, using either the TIFF or the TIF filenames. The TIFF’s flexibility is both blessing and curse, because no single reader reads every type of TIFF file. TIFFs are lossy and lossless; some offer relatively good lossless compression for bi-level (black&white) images. Some digital cameras can save in TIFF format, using the LZW compression algorithm for lossless storage. The TIFF image format is not widely supported by web browsers. TIFF remains widely accepted as a photograph file standard in the printing business. The TIFF can handle device-specific colour spaces, such as the CMYK defined by a particular set of printing press inks.

RAW

RAW refers to a family of raw image formats that are options available on some digital cameras. These formats usually use a lossless or nearly-lossless compression, and produce file sizes much smaller than the TIFF formats of full-size processed images from the same cameras. The raw formats are not standardized or documented, and differ among camera manufacturers. Many graphic programs and image editors may not accept some or all of them, and some older ones have been effectively orphaned already. Adobe's Digital Negative specification is an attempt at standardizing a raw image format to be used by cameras, or for archival storage of image data converted from proprietary raw image formats.
**PNG**

The PNG (Portable Network Graphics) file format was created as the free, open-source successor to the GIF. The PNG file format supports truecolor (16 million colours) while the GIF supports only 256 colours. The PNG file excels when the image has large, uniformly coloured areas. The lossless PNG format is best suited for editing pictures, and the lossy formats, like JPG, are best for the final distribution of photographic images, because JPG files are smaller than PNG files. Many older browsers currently do not support the PNG file format, however, with Internet Explorer 7, all contemporary web browsers fully support the PNG format. The Adam7-interlacing allows an early preview, even when only a small percentage of the image data has been transmitted.

**GIF**

GIF (Graphics Interchange Format) is limited to an 8-bit palette, or 256 colors. This makes the GIF format suitable for storing graphics with relatively few colors such as simple diagrams, shapes, logos and cartoon style images. The GIF format supports animation and is still widely used to provide image animation effects. It also uses a lossless compression that is more effective when large areas have a single color, and ineffective for detailed images or dithered images.

**BMP**

The BMP file format (Windows bitmap) handles graphics files within the Microsoft Windows OS. Typically, BMP files are uncompressed, hence they are large; the advantage is their simplicity, wide acceptance, and use in Windows programs.

**Vector formats**

As opposed to the raster image formats above (where the data describes the characteristics of each individual pixel), vector image formats contain a geometric description which can be rendered smoothly at any desired display size.

Vector file formats can contain bitmap data as well. 3D graphic file formats are technically vector formats with pixel data texture mapping on the surface of a vector virtual object, warped to match the angle of the viewing perspective.

At some point, all vector graphics must be rasterized in order to be displayed on digital monitors. However, vector images can be displayed with analog CRT technology such as that used in some electronic test equipment, medical monitors, radar displays, laser shows and early video games. Plotters are printers that use vector data rather than pixel data to draw graphics.

**CGM**

CGM (Computer Graphics Metafile) is a file format for 2D vector graphics, raster graphics, and text.
Video Formats

Have you ever checked the size of a graphic file you have saved, the same width and height of your screen, with full colour? It could be as much as 2 megabytes. Now imagine different ones being displayed 24 times each second, for 30 seconds - 1440 megabytes! That is how much storage you would need to record videos in the traditional frame-by-frame method, without a sound track.

To reduce the file size two types of compression can be applied to video file formats. The individual images that make up each frame can be compressed, similar to graphic files, and only the differences between frames are recorded. Incorporated with the image frames video files can integrate a sound track. Audio incorporated in video files is also compressed to reduce the file sizes.

Prior to the Internet whole videos were loaded into the computer’s memory before playing, requiring the user to wait. This wait could be considerable if a large file is to be viewed, over a slow Internet connection. To overcome this problem modern file formats allow streaming. Streaming is a process that will start playing a video before it has been completely downloaded. In an attempt to standardise file formats a group know as the Moving Picture Expert Group (MPEG) meet under the International Standards Organisation to define digital video and audio compression and decompression algorithms (CODECs). This has resulted in the development of the popular MPG file format. There are still individual manufactures such as Real Networks who are developing their own proprietary formats.

Table 1 lists some of the more popular file formats. To play them, the target computer requires player software. All common Microsoft and MPG formats can be played with the Media Player installed with modern versions of Windows. QuickTime, Real Media and MPG-4 files require installing a player.

<table>
<thead>
<tr>
<th>File Format</th>
<th>Common File Types</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-streaming</td>
<td>AVI</td>
<td>The traditional Windows based format and the most common video format found on data CDs. This older format creates a video composed of JPEG images stitched together in a very quick slide show. Audio is interlaced between images, to produce synchronized media. AVI files can be compressed using a variety of codecs.</td>
</tr>
<tr>
<td>Non-streaming</td>
<td>FLA/FLI</td>
<td>An older 3D file format produced by Autodesk Animator, limited to an 8-bit colour uncompressed data, and with no audio. This format retains its popularity due to being easily transferred to CAD packages.</td>
</tr>
<tr>
<td>Streaming</td>
<td>MOV</td>
<td>The traditional MAC based format. MOV files, can be streamed, but require the installation of a player Allows the inclusion of stereo audio.</td>
</tr>
<tr>
<td>Streaming</td>
<td>MPG-1</td>
<td>MPEG-1 compression can take a digital video and compress it up to a 50:1 ratio, with minimum distortion to quality. Allows the inclusion of stereo audio.</td>
</tr>
<tr>
<td>Streaming</td>
<td>MPG-2</td>
<td>MPEG-2 compression can take a digital video and compress it up to a 150:1 ratio, with minimum distortion to quality. Allows the inclusion of stereo audio.</td>
</tr>
<tr>
<td>Streaming</td>
<td>MPG-4</td>
<td>An emerging standard that can compress large file to an acceptable size (over 100 Mb files to under 10Mb), with minimum distortion to quality. The file format is designed to incorporate bit-mapped and vector images, with the ability to allow high level of interactions within players, beyond standard video controls. This format is still not supported by common players.</td>
</tr>
<tr>
<td>Streaming</td>
<td>ASF</td>
<td>This the Microsoft solution to MPG formats, with comparable compression rates. At this time it only supports mono audio when used over the internet.</td>
</tr>
<tr>
<td>Streaming</td>
<td>RM</td>
<td>Created by Real Networks, this format uses a proprietary compression technique. Offers high compression ratios and stereo audio.</td>
</tr>
</tbody>
</table>
Text Creation/Formats/Importing

Plain Text (ASCII) Files

.html/.htm
The language in which Web documents are authored. File Type: ASCII This file type requires a web browser, such as Navigator or Internet Explorer, for viewing.

.txt
A plain (ASCII) text file. File Type: ASCII These files can be viewed with a word processor like Microsoft Word or a simple text editor like Simple Text or BBEdit for the Mac. For the PC you can use Notepad that comes with the Windows operating system.

Formatted Documents

.doc
A common PC format for formatted text files. File Type: ASCII Although you may occasionally come across files with this extension that are not text documents, usually they are documents that were created using Microsoft Word or WordPerfect for Windows.

.pdf
Portable Document Format, a proprietary format developed by Adobe Systems, Inc. that allows formatted documents (including brochures or other documents containing artwork) to be transferred over the Internet so they look the same on any computer. File Type: Binary This file type requires the Adobe Acrobat Reader to view files and can be downloaded from the Adobe website.
Sound Files - Audio file format

The general approach towards storing digital audio is to sample the audio voltage which, on playback, would correspond to a certain position of the membrane in a speaker of the individual channels with a certain resolution — the number of bits per sample — in regular intervals (forming the sample rate). This data can then be stored uncompressed, or compressed to reduce the file size.

Types of formats
It is important to distinguish between a file format and a codec. A codec performs the encoding and decoding of the raw audio data while the data itself is stored in a file with a specific audio file format. Though most audio file formats support only one audio codec, a file format may support multiple codecs, as AVI does.

There are three major groups of audio file formats:

- Uncompressed audio formats, such as WAV, AIFF and AU;
- formats with lossless compression, such as FLAC, Monkey's Audio (filename extension APE), WavPack (filename extension WV), Shorten, Tom's lossless Audio Kompressor (TAK), TTA, ATRAC Advanced Lossless, Apple Lossless and lossless Windows Media Audio (WMA).
- formats with lossy compression, such as MP3, Vorbis, Musepack, ATRAC, lossy Windows Media Audio (WMA) and AAC.

Uncompressed audio format
There is one major uncompressed audio format, PCM, which is usually stored as a .wav on Windows or as .aiff on Mac OS. WAV is a flexible file format designed to store more or less any combination of sampling rates or bitrates. This makes it an adequate file format for storing and archiving an original recording. A lossless compressed format would require more processing for the same time recorded, but would be more efficient in terms of space used. WAV, like any other uncompressed format, encodes all sounds, whether they are complex sounds or absolute silence, with the same number of bits per unit of time. As an example, a file containing a minute of playing by a symphonic orchestra would be the same size as a minute of absolute silence if they were both stored in WAV. If the files were encoded with a lossless compressed audio format, the first file would be marginally smaller, and the second file taking up almost no space at all. However, to encode the files to a lossless format would take significantly more time than encoding the files to the WAV format. Recently some new lossless formats have been developed (for example TAK), which aim is to achieve very fast coding with good compression ratio.

Lossless audio formats
Lossless audio formats (such as the most widespread FLAC, WavPack, Monkey's Audio) provide a compression ratio of about 2:1.

Lossy audio formats
mp3 – the MPEG Layer-3 format is the most popular format for downloading and storing music. By eliminating portions of the audio file that are essentially inaudible, mp3 files are compressed to roughly one-tenth the size of an equivalent PCM file while maintaining good audio quality.
<table>
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<th>Glossary Of Key Words For All HSC Syllabi</th>
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<td><strong>Account</strong></td>
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<tr>
<td><strong>Analyse</strong></td>
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<tr>
<td><strong>Apply</strong></td>
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<tr>
<td><strong>Appreciate</strong></td>
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<td><strong>Assess</strong></td>
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<td><strong>Calculate</strong></td>
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<td><strong>Clarify</strong></td>
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<tr>
<td><strong>Classify</strong></td>
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<tr>
<td><strong>Compare</strong></td>
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<tr>
<td><strong>Construct</strong></td>
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<tr>
<td><strong>Contrast</strong></td>
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<td><strong>Critically (analysis)</strong></td>
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<td><strong>Deduce</strong></td>
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<td><strong>Define</strong></td>
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<tr>
<td><strong>Demonstrate</strong></td>
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<tr>
<td><strong>Describe</strong></td>
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<td><strong>Discuss</strong></td>
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<td><strong>Distinguish</strong></td>
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<td><strong>Evaluate</strong></td>
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<td><strong>Examine</strong></td>
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<td><strong>Explain</strong></td>
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<td><strong>Extract</strong></td>
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<td><strong>Extrapolate</strong></td>
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<tr>
<td><strong>Identify</strong></td>
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<td><strong>Interpret</strong></td>
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<td><strong>Recall</strong></td>
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<td><strong>Recount</strong></td>
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<tr>
<td><strong>Summarise</strong></td>
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<td><strong>Synthesise</strong></td>
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