**Study Skills**
**Course Milestones for Students**

| **Course Title: Design & Manufacture** | **Level: Advanced Higher** |
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| **Work to be covered/Topics/Activities/Assignments** | | | |
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| **Month** | **Unit 1 Product Analysis** | | |
| **June-December** | **1**<br>**Analyse the performance of a commercial product by:** | 1.1<br>Evaluating the performance of a commercial product by:<br><br>♦ producing an appropriate strategy to evaluate selected issues and/or aspects of the product<br>♦ identifying a range of suitable tests or activities to gather objective information on the product<br>♦ undertaking a range of suitable tests and activities on the issues or aspects identified, and present objective results and information<br>♦ present valid conclusions which relate to the performance of the product, referencing information gathered | Candidates could undertake a range of activities to identify important issues or aspects of the product,<br>eg a user trip or functional analysis that informs their evaluation strategy.<br><br>The strategy could be presented in a range of ways,<br>eg text, presentation, storyboard, sequence or other appropriate method.<br><br>Candidates could develop a matrix to highlight what information they need to find out, why it is important to the evaluation, how it will be tested and evaluated.<br><br>Performance aspects could include: aesthetics, ergonomics, functionality, safety, durability, maintenance, value for money and user interface. |
| | | 1.2<br>Explaining the function of, and the relationships between, the main component parts by:<br><br>♦ identifying the main external and internal component parts of the product that relate to its operation and use<br>♦ explain how these components contribute to the product's operation and use | This could be approached by having access to a range of dismantled products, where candidates can investigate the internal workings and any standard components used.<br><br>In addtition, candidates are expected to dismantle their selected product to gather information and take photographs as required.<br><br>Candidates could carry out desk research to gather information about the operational use of components. |

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| | **2**<br>**Analyse the production of a commercial product by:** | 2.1<br>Explaining the suitability of the materials, manufacturing processes and production methods used by:<br><br>♦ identifying materials used in the manufacture of the products and explain their suitability by considering a range of issues<br>♦ identifying processes used in the manufacture of the product and explain/justify their suitability by considering a range of issues<br>♦ identifying the production method most suitable for the product and explain/justify its suitability by considering a range of issues | Candidates could disassemble the product to identify different materials and manufacturing processes used.<br><br>Explanations could be based on issues such as:<br>♦ performance requirement of individual parts<br>♦ method of production<br>♦ volume of production<br>♦ economics<br>♦ design for re-use<br>♦ obsolescence<br>♦ aesthetics<br><br>Candidates could have considered the features of the product and described suitable production methods such as mass, batch, flow, one-off, from raw material stage to completion. |
| | | 2.2<br>Explaining the function of specific manufactured features by:<br><br>♦ identifying and explain the function of a range of specific manufactured features of the product | Manufactured features could include ribs, webs, radius corners, draft angles, split lines, ejection/injection points, wall thickness, embossing, surface finish and voids.<br><br>Candidates could consider a previously disassembled product. |
| | | 2.3<br>Explaining the suitability of assembly methods by:<br><br>♦ identifying the main internal and external assembly features and explain their suitability | Features could include bosses, webs, clips, location points, threads, and permanent and semi-permanent fixings.<br><br>Candidates could investigate how and why features and assembly methods are used in a range of existing products.<br><br>Candidates could disassemble the product to identify different assembly features.<br><br>Explanations could be in the form of annotated photographs/diagrams/ sketches. |
| | **3**<br>**Analyse the impact of a product by:** | 3.1<br>Analysing the impact of a commercial product on society, economy and the environment by:<br><br>♦ carrying out research into the impact of the product on society, the economy and the environment<br>♦ present valid conclusions that relate to the impact of the product, referencing information gathered | Candidate could carry out desk research to gain information about the impact of existing products on the society, the economy and the environment.<br><br>Evidence could be in a range of formats such as: brief report, charts, diagrams, photographs and annotations. |

| Work to be covered/Topics/Activities/Assignments | | | |
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| **Month** | **Unit 2 Product Evolution** | | |
| **June-December** | **1**<br>**Research factor that have influenced the evolution of the design and manufacture of a selected commercial product by:** | 1.1<br>Researching the influences of developments in materials, manufacturing and technology by:<br><br>♦ selecting an appropriate commercial product<br>♦ presenting research findings on a number of key developments in materials and manufacturing processes that have influenced the evolution of the design and manufacture of the selected product | These findings should cover a period of time and should demonstrate significant or influential developments.<br><br>Any stated facts should be referenced appropriately.<br><br>Candidates could consider the developments and changes in materials technologies, their use and application, and production and manufacturing techniques.<br><br>Forms of evidence could include annotated timeline (with supporting images), report and presentation (slides and notes). |
| | | 1.2<br>Researching the influences of external factors by:<br><br>♦ presenting research findings on a number of key external factors that influenced the evolution of the design and manufacture of the product selected for Assessment Standard 1.1<br><br>These findings should cover a period of time and should demonstrate significant or influential changes.<br><br>Any stated facts should be referenced appropriately. | Key external factors could include economics, global events, scientific and engineering developments, fashion and style, social attitudes and legislation.<br><br>Candidates could include the influence of noted designers or design movements.<br><br>Significant or influential changes could include technological changes/improvements, popularity, availability, affordability, user interface (improvements in), and environmental impacts.<br><br>Forms of evidence could include annotated timeline (with supporting images), report and presentation (slides and notes). |
| | **2**<br>**Investigate the impact of new and emerging technologies on the evolution of the design and manufacture of a selected commercial product by:** | 2.1<br>Describing a range of new and emerging design and manufacturing technologies by:<br><br>♦ investigating and describing the main features of at least two new and emerging technologies relevant to design and manufacture | New and emerging technologies could include approaches to design, manufacturing and production, availability, and potential use of new materials.<br><br>Forms of evidence could include brief report and presentation (slides and notes). |
| | | 2.2<br>Explaining the impact of new and emerging design and manufacturing technologies on a selected commercial product by:<br><br>♦ explaining the potential impact of at least one new and emerging technology on the design and manufacture of a selected commercial product | Potential impacts could be related to product performance, aesthetics, environmental impact, user interface, approaches to repair, re-use, upgrading and economics.<br><br>Forms of evidence could include annotated graphics, brief report and presentation (slides and notes). |

| Work to be covered/Topics/Activities/Assignments | | | |
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| **Month** | **Unit 3 Product Development** | | |
| **June-December** | **1**<br>**Identify and respond to a design opportunity by:** | 1.1<br>Researching a situation or product using appropriate techniques by:<br><br>♦ undertaking a range of appropriate activities to analyse a situation or products, to identify a possible design opportunity<br>♦ identifying areas for improvements such as:<br>function, user interface, market appeal, economics, environment<br>♦ undertaking activities such as:<br>site visits, interviews, questionnaires, surveys, user trips, observations | Task may involve a problem situation, or candidates could identify a product that presents opportunity for redesign.<br><br>Candidates could be provided with an open design task that requires further research to identify design opportunities.<br><br>Setting a design task with fundamental requirements of significant restraints (eg target market, cost, and environment), creates a more meaningful design task that will require thorough research.<br><br>General situations or products that only require restyling should be avoided.<br><br>Candidates should be encouraged to plan and undertake activities such as site visits, interviews, questionnaires and surveys, to identify design opportunities within a given situation. These activities should highlight a range of possible design opportunities.<br><br>Further research and analysis will be required to justify the most promising design opportunity. |
| | | 1.2<br>Producing a design brief by:<br><br>♦ producing the design brief<br><br>The brief will be based on research and should contain details of who, what, where and why. | Evidence is likely to be in the form of text. |
| | | 1.3<br>Developing a design specification by:<br><br>♦ developing a detailed design specification, outlining all requirements of selected design opportunity including:<br>function, aesthetics, user interface, safety, life expectancy, materials, manufacture, economics, environment | Candidates should be encouraged to use the research gathered in Assessment Standard 1.1 to develop a design specification.<br><br>Additional research could be required to complete details of the specification.<br><br>The specification should be detailed enough to allow meaningful development and evaluation of the design proposal.<br><br>It should be noted that other forms of specification may be developed at a later stage. |

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| | **2**<br>**Create and evaluate a design proposal by:** | 2.1<br>Generating ideas and/or concepts by:<br><br>♦ generating ideas/concepts that provide a suitable platform for further development<br>♦ using models and graphics appropriately<br>♦ carrying out on-going evaluation of ideas/concepts using appropriate methods | Forms of evidence could include sketches and drawings, annotations, text, models and photographs.<br><br>Candidates could use idea generation techniques and/or generate ideas and/or concepts at any stage of the design. |
| | | 2.2<br>Exploring, refining and evaluating ideas and/or concepts towards a design proposal by:<br><br>♦ exploring and refining ideas and/or concepts<br>♦ using models and graphics to explore and refine ideas and/or concepts<br>♦ carrying out on-going evaluation of ideas and/or concepts using appropriate methods<br>♦ resolving issues relating to commercial manufacture of proposal resolving areas of conflict | Forms of evidence could include sketches and drawings, annotations, text, models and photographs.<br><br>Candidates could explore and resolve issues related to the specification, eg:<br><br>♦ function<br>♦ aesthetics<br>♦ user interface<br>♦ safety<br>♦ life expectancy<br>♦ materials<br>♦ manufacture<br>♦ economics<br>♦ environment |
| | | 2.3<br>Providing technical detail for the manufacture and assembly of a design proposal by:<br><br>♦ providing enough detail to allow manufacture of the proposal; details should include:<br>features, assembly methods, materials to be used, manufacturing processes to be used, production systems to be used | Features and assembly methods could include ribs, webs, radius corners, draft angles, split lines, wall thickness, embossing, surface finish, voids, bosses, clips, location points, threads, and types of fixings.<br><br>Production system details could include information on project planning, JIT, jigs, patterns, standard components, CAD/CAM, and CNC machining and quality control.<br><br>Forms of evidence could include detailed sketches and drawings, annotations, text, parts lists, models, photographs, manufacturing plans, Gantt charts and flowcharts. |

| Course Assessment | | | | | |
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| **Month** | **Component 1 PROJECT** | **Candidates ability to:** | **Activity** | **Marks** | **Marks allocated for** |
| **February-April** | **Course Assignment TASK (60% of overall grade)**<br><br>**Deadline 31 March 2017**<br><br>**For applying design skills and knowledge and understanding, 120 marks will be allocated in 9 areas, according to the candidates ability to:**<br><br>• Defining a design opportunity – analysis and research<br>• Project planning<br>• Generating and exploring ideas<br>• Refining ideas<br>• Applying graphic techniques to inform and communicate design decisions<br>• Applying modelling techniques to inform and communicate design decisions<br>• Analysing and evaluating to inform design decisions<br>• Applying knowledge and understanding of materials and manufacturing processes<br>• Applying knowledge and understanding of design issues | Defining a design opportunity – analysis and research | Analysis of the problem or situation, the identification of the main issues, and the subsequent research carried out in connection with the It should not be limited to any specific stage in the process. For example, whilst much of the evidence is likely to be generated at the early stages of the design activity, further evidence of analysis and research may be generated when and if the candidate revisits the problem in order to clarify specific issues.<br><br>Candidates should have presented results of research, which may be supported by:<br><br>photos, sketches, video clips, charts, tables and graphs<br>analysis of surveys and questionnaires<br>The requirements of a solution will be based on:<br><br>conclusions drawn from research, most likely to be presented in the form of a specification<br><br>Evidence may include the candidate's reflective commentaries within their design work or 'record of progress'. | **10** | ♦ the analysis identifies all of the main project issues to be considered and/or researched, and the candidate has explained their relevance in detail<br>♦ all of the conclusions drawn from initial analysis and research are valid and evidence-based<br>♦ complete and detailed requirements for the solution are provided and are based on valid conclusions |
| | | Project planning | This aspect of the project should be revisited and updated as required throughout, as the candidate makes alterations in light of decisions and changes to their design proposal. Bearing in mind this iterative process, the planning stage should not be marked until after project completion.<br><br>The intention of the plan is to assist the candidate throughout the project. For example they will have to consider what activities they will have to carry out and when, what resources will be needed, any special resources to be acquired or booked, meetings, interviews, working with external partners or business if required, interim and final deadlines. It will also assist them in reflecting on their successes and any scheduling challenges faced within the project.<br><br>Updates and refinement to the project plan should be dated to show the frequency and regularity of review. Review does not always need to result in changes — where this is the case, this should be noted.<br><br>The plan could be in the form of a Gantt chart which shows revisions in the form of versions over the period of the project, eg project plan version 1.0, 1.1, 1.2 etc.<br><br>In such cases, the candidate should be marked on the work produced independently, with **appropriate assessor comments** made against this section in the candidate's marking record to support the mark awarded. | **10** | ♦ project plan with full details for key activities, resource requirements, time management proposals and intermediate target setting<br>♦ evidence of on-going refinements to plan with detailed explanations for changes |

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| | | Generating and exploring ideas | New ideas may appear throughout the design work and at different stages to support thinking and decision-making. There should be sufficient and appropriate detail provided by the ideas to allow design decisions to be made. Additional supporting evidence can be sourced from the candidate's reflective commentaries in their design work and/or their 'record of progress'.<br><br>In some cases candidates, rather than generating a range of ideas, may have explored one concept and produced a significant range of diverse ideas for major features or components. This is acceptable.<br><br>Idea generation techniques should be used where appropriate and useful. It is unlikely that all ideas will be creative in the ways in which they attempt to meet the requirements or specification — instead the assessor should look generally at the level of creativity demonstrated.<br><br>Candidates are expected to be thorough in the exploration of their ideas as they progress towards a design proposal.<br><br>Exploration should consider all appropriate design issues and materials and manufacturing requirements. | **10** | ♦ most ideas generated are very creative in the ways they attempt to meet the requirements or specification<br>♦ there is detailed exploration of ideas |
| | | Refining ideas | Candidates are expected to be detailed in the refinement of their ideas as they progress towards a design proposal.<br><br>Refinement should consider all appropriate design issues and materials and manufacturing requirements. Candidates should make use of on-going or early research to confirm their refinement decisions.<br><br>Changes from the ideas to the final design proposal will have been made for valid reasons and these reasons should be clearly communicated by the candidate. Evidence may be sourced from reflective commentaries on the candidate's design work and/or their 'record of progress'.<br><br>The design proposal should address the specification and be detailed enough to allow commercial manufacture. | **20** | ♦ refinement of ideas is detailed<br>♦ the proposal satisfies all of the requirements or specification with little or no further development or refinement required<br>♦ refinement makes highly effective use of research and/or design decisions which relate to materials and manufacturing<br>♦ refinement makes highly effective use of research and/or design decisions which relate to design issues |
| | | Applying graphic techniques to inform and communicate design decisions | Candidates are required to use appropriate graphic techniques to communicate:<br>♦ the development of the design proposal, eg the range of ideas, exploration and refinement of ideas<br>♦ the final details of the proposal, eg the manufacturing details, dimensions, assembly and aesthetics<br><br>The quality of the graphic should reflect its purpose.<br><br>Graphics can be computer-generated and/or manual.<br><br>It is likely that a candidate will use a range of graphics in their design work which will include manual and computer-generated graphics.<br>The design work should show that the candidate is fully aware of the purpose of graphic types, and apply recognised conventions, where appropriate and practicably possible, in order to communicate ideas and information clearly and effectively. | **10** | ♦ graphic techniques are used appropriately and effectively on all occasions to communicate during idea generation, exploration and refinement<br>♦ an appropriate range (or type)of graphic techniques is applied to communicate the final details of the design proposal and they are highly effective<br>♦ consistent application of recognised conventions |

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| | | Applying modelling techniques to inform and communicate design decisions | Candidates should demonstrate the ability to apply appropriate modelling techniques throughout the design process.<br>These may include:<br><br>♦ generation, exploration and refinement of ideas<br>♦ aspects of testing<br>♦ checking ergonomics/user interface<br>♦ resolving conflicting issues<br>♦ presentation of proposal<br><br>The quality and detail of the modelling should always reflect its purpose. Modelling can be in the form of computer-generated and/or physical models, according to the design issues being explored or decisions being communicated. It is likely that candidates will use a range of models in their design work which will include physical models and computer-generated models. | **10** | ♦ modelling techniques are used effectively to inform design decisions<br>♦ modelling techniques are used effectively to communicate design decisions<br>♦ modelling techniques are appropriate to purpose in terms of quality and detail |
| | | Analysing and evaluating to inform design decisions | Candidates should demonstrate the ability to identify critical points in the development of the proposal, and evaluate and justify decisions taken at these points.<br><br>Decisions should be based on quantitative and qualitative data. Therefore, a range of evaluation techniques is likely to be required.<br><br>Decisions may be recorded in the form of annotations, notes, tables, summaries.<br><br>The requirements of the solution should be addressed in the evaluation of final proposal. | **15** | ♦ detailed analysis, based on personal knowledge and/or detailed research and/or evaluation techniques<br>♦ all decisions taken at critical points in the development of the design proposal are fully justified<br>♦ the evaluation of the final design proposal is effective in covering all aspects of the requirements or specification for the solution<br>♦ effective use of reflective commentary from design work and/or 'record of progress' relating to analysing and evaluating |
| | | Applying knowledge and understanding of materials and manufacturing processes | Candidates should apply knowledge of suitability of materials **and** knowledge of suitability of processes in terms of function, performance, conditions of use, economics, manufacturing processes, assembly methods, life span and environmental issues.<br><br>Enough detail should be given to allow manufacture of the proposal.<br><br>Candidates should carry out appropriate research into materials and processes as required.<br><br>Candidates should provide enough detail to allow manufacture of the proposal. | **15** | ♦ knowledge of materials has been applied to good effect in developing the design proposal<br>♦ knowledge of processes has been applied to good effect in developing the design proposal<br>♦ all of the key materials and manufacturing process details for the final proposal are included |
| | | Applying knowledge and understanding of design issues | Design issues that the candidate has selected should be relevant to the task, problem or situation.<br><br>Candidates should apply knowledge of design issues which are relevant to the task. These are likely to include aspects of function, performance, market, aesthetics, and ergonomics.<br><br>Candidates should apply enough knowledge and understanding of issues to allow clear development of the proposal. | **20** | All design issues are considered and those relevant to the development of the design proposal are identified. In relation to these identified design issues:<br><br>♦ all relevant issues are explored/researched thoroughly<br>♦ all valid relationships or dependencies are explained<br>♦ knowledge is applied to good effect<br>♦ all design decisions and conflicts are explained in detail |

| **Course Assessment** | | |
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| Month | **Component 2**<br>**QUESTION PAPER** | The purpose of the question paper is to assess learners' skills, knowledge and understanding they have acquired.<br>The question paper will have 80 marks *(40% of the total mark, 2 hour duration).*<br><br>The question paper will give learners an opportunity to:<br><br>♦ demonstrate their understanding of the design process in a commercial context<br>♦ demonstrate their understanding of materials and manufacturing processes<br>♦ comment on historic design influences in terms of technology, materials and manufacturing processes<br>♦ demonstrate their understanding of visualisation techniques and technologies and their application<br>♦ demonstrate reasoning ability by determining and applying design factors to specific design situations<br>♦ demonstrate an understanding of the influences and needs of markets and users<br>♦ comment on the impact of commercial design and manufacturing decisions on the environment and society<br><br>The question paper will have two Sections.<br><br>**Section 1** will have 30 marks and will require candidates to demonstrate their knowledge of the influences that contribute to the evolution in the design and manufacture of products.<br><br>**Section 2** will have 50 marks and will require candidates to demonstrate their knowledge of design and manufacture through integrated questions.<br><br>The question paper will consist of extended response questions and will give learners the opportunity to demonstrate the application of knowledge and understanding to answer questions by drawing on and applying knowledge and understanding from the table provided in the 'Further mandatory information on Course coverage' section at the end of this *Course Assessment Specification*. |

| Designing | | |
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| **Members of a design team** | Designers, market researchers, accountants, engineers, manufacturers. Relationships between team members. Types of teams. In-house v consultants. | |
| **Market** | Consumer demands, social expectations, niche marketing, branding, introduction of new products. Endorsements, product placement, product promotion, market trends, product lifecycle. Product failures (reasons, results and corrections). Changing markets. Influence of politics and the economy. Methods of maintaining market share. | |
| **Product re-design** | Reasons, alternatives, re-launch of products, product testing, identification of problems with existing products. | |
| **Aesthetics** | Factors influencing aesthetics, influences of fashion, market trends, style. | |
| **Ergonomics** | Anthropometrics, psychology, physiology. Use of percentiles, user interface, inclusive design, consumer safety. | |
| **Economics** | Costs (fixed and variable), safety (British Standards, kite marks), market opportunity, intellectual property rights (confidentiality, patents, copyrights, design rights, trademarks, registered designs), value for money, production systems. | |
| **Conflict resolution** | Resolution and balance between competing design issues during design and manufacture of products, eg function versus aesthetics, economics versus environment. Relationships between consumer, designer and manufacturer. | |
| **Evolution of products** | The critical stages, and the historical development and impact of: materials and manufacturing technologies, socio-economics, fashion and style, and influential designers and design movements. | |
| **Environmental** | Sustainability in manufacture, use and re-use, packaging. Climate change, carbon footprints, sustainable resources, mass production and efficiency, green design, government policy, recycling, consumer awareness/changing attitudes. | |
| **Visualisation** | Graphic techniques | Annotated sketches, working drawings, pictorial views exploded views, dimensioned views, illustration techniques, computer-aided graphics, and use of scale.<br>The role of graphics in the design process.<br>Use of graphic techniques to develop and communicate ideas. Orthographic drawing (elevation, end elevation, plan, outline, hidden detail, centre-line, dimensioning, section, hatch lines. Detail in drawings (wall thicknesses, fillet radii, rib details). |
| | Modelling | Scale models, mock-ups, fully crafted prototypes, test models, computer generated models, part-product models, simulations, rapid prototyping. Use of appropriate modelling. The role of modelling in the design process. Application of modelling techniques to develop and communicate ideas. Detail, progression of models. |
| | Presenting design responses | Justification and testing. |

| Manufacturing | | |
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| **Materials** | Plastics | Polythene (high and low density), polyvinyl chloride, polystyrene, nylon, cellulose acetate, acrylic, polypropylene, ABS, epoxy resin, melamine formaldehyde, urea formaldehyde, polyester resin, glass-reinforced plastic, carbon-fibre plastics, elastomers, biopolymers. |
| | Common materials | General uses and properties of woods, plastics, metals and timber derivatives. |
| | Composites | Fibre reinforced polymers, GRP, Kevlar, carbon fibre. |
| **Identification of materials** | | Colour, surface texture, weight, properties, labelling and symbols. |
| **Processes** | Common materials | General manufacturing processes for wood, metal and plastic materials. |
| | Composites | Benefits of composite materials. Carbon fibre, Kevlar based materials, glass-reinforced plastics, engineered woods and materials, wood plastic composites. |
| | Joining processes | Permanent, semi-permanent, temporary, adhesive bonding. |
| | Identification of processes | Form, material, split lines, injection points, ejector points, shrinkage, draft angle, intricate form, clean and precise, flash, thinning of sheet material at corners, shear marks, cross-section over length, surface texture. |
| | Production systems | One-off, batch, mass, line, flow. Gantt charts, flow charts, project planning, JIT, jigs, patterns, standard components, CAD/CAM, CNC machining. Quality control, quality assurance. |
| | Functional analysis of products | Assembly methods, wall thicknesses, ribs, material testing. |
| | Advances in materials and technology | Thermo-chromic pigments and films, phosphorescent pigments, shape memory alloys, piezoelectric devices, fibre optics, liquid crystal displays, genetic modification of woods, biodegradable plastics. |
| | Production technology and scheduling processes | Benefits to designer of: CAD, CAM, CNC, stereo and technology lithography, 3D scanning, quick change injection moulding techniques, Quick Response Manufacturing (QRM), Electronic Point Of Sale (EPOS). Flexible Manufacturing Systems (FMS), miniaturisation. |
| | Advances in communication | In supporting design activities, the uses and benefits of: e-mail, video conferencing, virtual reality, file sharing, mobile and touch screen interaction, storage, network access. |
| | CAM processing | CNC — laser cutters and engravers, multi-axis routers and mills, plotter cutters, lathes, 3D printing, fusion deposition or stereo lithographic modelling. Additive and subtractive manufacturing/modelling. |
| **Project planning** | | |
| Practical project planning in terms of use and allocation of time, resources and equipment requirements and when they will be needed, practical use of planning tools, eg Gantt charts, start and finish dates of key activities, review and update. | | |