Design, Technology and Engineering

2020 Subject Outline
Stage 1 and Stage 2

This subject outline has been accredited. It is provided in draft, pre-edited form for planning purposes and for use at the implementation workshops.

The published version of this subject outline will be available online in Term 4, 2019.

The redeveloped Board-accredited Stage 1 and Stage 2 subject outlines will be taught from 2020.
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INTRODUCTION

SUBJECT DESCRIPTION

Design, Technology and Engineering is a 10-credit subject or a 20-credit subject at Stage 1.

In Design, Technology and Engineering students use the design and realisation process to engineer solutions for the development of products or systems. Design, Technology and Engineering has four contexts: digital communication solutions, industry and entrepreneurial solutions, material solutions and robotic and electronic systems.

The subject provides a flexible framework that encourages students to be creative, innovative and enterprising in their chosen context. They apply critical problem solving skills and incorporate technologies to address design problems and challenges. This subject incorporates the transfer of interdisciplinary skills and knowledge and promotes individualised and inquiry based learning. Design, Technology and Engineering provides opportunities for students to apply engineering processes and use new and evolving technologies.

In Stage 1 students use the design and realisation process. They learn to create a design brief that provides the basis for the development of potential solutions to design problems and review design features, processes, materials and production techniques to assist with the realisation of the solution.

A solution in this subject is an outcome of the design and realisation process in relation to the chosen context. A solution could be fully realised or a model, prototype, system, part, process (i.e. procedures to output a product) or product.

Students analyse influences on a product or system including ethical, legal, economic, and/or sustainability issues. They consider the practical implication of these issues on society or design solutions.

Students apply appropriate skills, processes, procedures and techniques whilst implementing safe work practices in the creation of the solution.

Student learning is reported for the following contexts:

- Design, Technology and Engineering — Digital Communication Solutions
- Design, Technology and Engineering — Industry and Entrepreneurial Solutions
- Design, Technology and Engineering — Material Solutions
- Design, Technology and Engineering — Robotic and Electronic Systems
CAPABILITIES

The capabilities connect student learning within and across subjects in a range of contexts.

The SACE identifies seven capabilities. They are:

- literacy
- numeracy
- information and communication technology (ICT) capability
- critical and creative thinking
- personal and social capability
- ethical understanding
- intercultural understanding.

Literacy

In this subject students extend and apply their literacy capability by, for example:

- using a range of sketches, graphical, digital, or computer-generated images to communicate product or systems design ideas to suit particular contexts and audiences
- understanding and using language and terminology specific to design and technology in written or oral forms to communicate ideas about design solutions
- understanding and applying specific instructions in relation to systems, processes, and safe operating procedures
- interpreting technical information
- using a variety of communication formats, including digital technologies to demonstrate understanding and analysis
- using language for different purposes including to interpret, discuss and explain concepts, issues, problems and solutions
- reading and interpreting online documentation and acknowledging resources appropriately.

Numeracy

In this subject students extend and apply their numeracy capability by, for example:

- selecting and using appropriate measurement tools and programs
- applying numerical calculations appropriate to the context
- displaying numerical information in accordance with correct technical standards and procedures
- interpreting numerical data for relevance
- understanding and using graphs, spreadsheets, diagrams, codes, and statistics to communicate technical data, properties of materials or systems information
- creating tables, charts or diagrams to define product specifications such as measurement
- applying the scientific method to the design and construction processes of the solution e.g. testing material characteristics or suitability.
Information and communication technology (ICT) capability

In this subject students extend and apply their ICT capability by, for example:

- using relevant digital technologies to communicate design intent
- locating and accessing information using digital technologies
- presenting findings or solutions using multimodal approaches such as a multimodal design brief
- using specialised programs and tools to develop solutions such as Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM)
- understanding the impact of ICT.

Critical and creative thinking

In this subject students extend and apply their critical and creative thinking capability by, for example:

- analysing existing product or system characteristics and features to inform the design and realisation process
- visualising possibilities and scoping solutions
- refining the design development in response to results of testing and research
- identifying and deconstructing problems
- using initiative in designing products or concept solutions
- evaluating existing and proposed designs of products or systems
- designing innovative, creative, and appropriate solutions using materials available
- critically evaluating potential entrepreneurial opportunities e.g. patents, marketing and distribution, mass production, online publishing, crowd sourcing.

Personal and social capability

In this subject students extend and apply their personal and social capability by, for example:

- listening to and respecting the perspective of others
- participating in inquiry-based activities that foster problem-solving and practical application skills
- sharing ideas about problems, progress and innovative solutions
- having opportunities to interact with people in different contexts and be involved in problem solving
- working collaboratively face to face or online to develop imaginative, innovative and enterprising outcomes
- planning and working in productive, creative, collaborative, and independent ways
- making decisions and taking initiative in designing products or solutions
- acquiring practical skills, knowledge, and understanding related to the design, development and realisation of a solution
- understanding how design affects individual, groups and or society
- developing entrepreneurial skills
• planning effectively and managing time.

Ethical understanding
In this subject students extend and apply their ethical understanding capability by, for example:
• evaluating the reliability of information for accurate decision making
• understanding ethical implications and sustainability through considered selection and use of materials, processes and production techniques
• recognising the importance of responsible participation in social, economic, environmental, scientific and/or ethical decision making
• applying an understanding of personal and group safety in a work environment
• reviewing the impact of technological practices, products, or systems on individuals, society and sustainability.

Intercultural understanding
In this subject students extend and apply their intercultural understanding capability by, for example:
• understanding that the process of designing and implementing a design solution is influenced by cultural factors
• valuing cultural diversity when working in groups or solving problems
• respecting and engaging with different cultural perspectives, skills and customs, and exploring these using various technologies
• researching different cultural traditions that impact on design concepts
• exploring design issues in local, national, and/or global contexts to expand knowledge of and create solutions for a diverse range of individuals, groups and societies.
ABORIGINAL AND TORRES STRAIT ISLANDER KNOWLEDGE, CULTURES, AND PERSPECTIVES

In partnership with Aboriginal and Torres Strait Islander communities, and schools and school sectors, the SACE Board of South Australia supports the development of high-quality learning and assessment design that respects the diverse knowledge, cultures, and perspectives of Indigenous Australians.

The SACE Board encourages teachers to include Aboriginal and Torres Strait Islander knowledge and perspectives in the design, delivery, and assessment of teaching and learning programs by:

- providing opportunities in SACE subjects for students to learn about Aboriginal and Torres Strait Islander histories, cultures, and contemporary experiences
- recognising and respecting the significant contribution of Aboriginal and Torres Strait Islander peoples to Australian society
- drawing students’ attention to the value of Aboriginal and Torres Strait Islander knowledge and perspectives from the past and the present
- promoting the use of culturally appropriate protocols when engaging with and learning from Aboriginal and Torres Strait Islander peoples and communities
LEARNING SCOPE AND REQUIREMENTS

LEARNING REQUIREMENTS

The learning requirements summarise the knowledge, skills, and understanding that students are expected to develop and demonstrate through their learning in Stage 1 Design, Technology and Engineering.

In this subject, students engage in the Design and Realisation Process and are expected to:

1. review design features, processes, materials, and production techniques and apply creative thinking to the design of a solution
2. plan and develop design concepts and communicate potential features and solutions to a problem or challenge
3. apply knowledge and understanding of skills, engineering procedures, and techniques using technology to realise the solution
4. evaluate processes used in design development and realisation of the solution
5. research and discuss ethical, legal, economic and/or sustainability issues related to technology, materials selected, processes used and/or solution design.
The Design and Realisation Process

The design and realisation process is a flexible framework and forms the structure of the subject. The following are components of a coherent and dynamic design progression. This process is rarely linear, and designing should be seen as cyclical with many possible solutions, rather than a simple step by step process.

![Diagram of Design and Realisation Process]

- **Investigation and Analysis**
  - identify end users, need, problem or opportunity
  - research and analyse factors to inform a design brief
  - create design brief outlining context, constraints and considerations
  - identify criteria to evaluate how well the finished product satisfies the design brief

- **Evaluation**
  - evaluate how effectively the design specifications have been met
  - recommended improvements
  - recording any refinements and modifications
  - visual record of any refinements and modifications

- **Design Development and Planning**
  - demonstrate critical and creative thinking
  - create concept sketches, drawings, prototype
  - testing, modelling potential ideas
  - design options, selection and justification
  - show product specifications through working technical drawings and or content tables
  - create a sequence plan and timeline

- **Solution Realisation**
  - demonstrate evidence of product or solution
  - create solution using safe work practices

Any stage can be revisited throughout the Design and Realisation Process.
Investigation and Analysis

The design and realisation process should begin with the identification of a problem or opportunity followed by an initial investigation and research analysis. The creation of a design brief should specify constraints, considerations and propose creative and innovative solutions. Students define criteria to evaluate how well the finished solution meets the requirements of the design brief.

Possible investigation and analysis strategies or techniques may include, for example:

- collaborate with peers to use visual tools e.g. mind mapping to explore concepts, problems or opportunities
- investigating and interpreting solution design factors such as
  - technologies- tools, processes and manufacturing methods
  - materials – characteristics and properties
  - legal responsibilities- patents, safety requirements, intellectual property, creative commons
  - economic considerations – time and cost
  - sustainability – life cycle analysis, fair trade, customs, carbon footprint, environmental impact
  - ethical application of the end product
  - innovation and creativity- inventing or improving products
  - target audience, end user and potential for entrepreneurship and marketing
- creating a written or multimodal design brief that includes key criteria and/or constraints such as function and/or aesthetics
- analysing existing product or system characteristics and features to inform the design and realisation process
- collecting and analysing data from target or end point users for a purpose e.g. survey, questionnaire
- researching and analysing ideas from different contexts such as the manufacturing sector or emerging technologies
- researching historical design, period influences or different cultural traditions
- acknowledging and correctly referencing sources of information and ideas
- conducting peer review and collecting feedback about the design brief
- critically analyse sources of information for reliability and validity.

Design Development and Planning

Another component of the design and realisation process is design development and planning in response to an established brief. This involves innovation, invention, iteration and creativity to develop a solution for a problem or opportunity. Students document their design ideas and make plans to use the available resources such as time, materials and technologies to realise the solution. They test, adapt and validate the design prior to realisation.

Possible design development and planning strategies or techniques may include, for example:

- use critical and creative thinking to devise a solution
- use ideation strategies such as adapting, modifying, substituting or rearranging to improve the solution
• creating a design brief showing specific aspects of the design development and planning
• creating working drawings, concept sketches, prototypes, story boards, flow charts, simulation or 3D modelling
• working collaboratively, face to face or online to develop imaginative, innovative, and enterprising outcomes e.g. with peers, industry, tertiary education or community
• applying interdisciplinary concepts e.g. artistic, scientific, mathematical and engineering concepts appropriate to the planning and designing of the product or system
• preparing timelines and procedures using visual organisers such as Gantt charts and tables showing sequencing
• conducting and recording the results of testing (e.g. photo essay, video, result tables, annotated images) of possible materials and processes through experimentation, trial and error or applying secondary research
• use critical and creative thinking to adapt the design development in response to results of testing and research
• justifying design solutions based on investigations and research analysis
• creating a table, chart or diagram to define product specifications e.g. measurement, materials to be used, processes required.
• applying the scientific method to the design and construction processes of the solution e.g. testing material characteristics or suitability
• using relevant digital technologies to communicate design intent

Solution realisation

This component (stage) of the design and realisation process involves realising a solution. A solution is the outcome of applying technological skills to meet the requirements of a design and realisation brief.

A solution in this subject is an outcome of the design and realisation process in relation to the chosen context. A solution could be fully realised or a model, prototype, system, part, process (i.e. procedures to output a product) or product

Possible solution realisation strategies or techniques may include, for example:
• using appropriate processes and production techniques
• creating solutions to the planned design specifications
• developing practical and technological skills and applying them to a range of applications
• developing solutions to technical and engineering problems that may arise during realisation such as accuracy of machinery, quality of materials and components, understanding of software programs
• apply appropriate safety processes including physical and online environments

Evaluation

The evaluation component of the design and realisation process involves judging the quality of the product against the criteria specified in the design brief and recommending improvements.
Possible evaluation strategies or techniques may include, for example:

- evaluating, individually and/or collaboratively, how effectively the requirements of the design brief specifications have been met
- reviewing criteria, standards, reliability, safety, quality, and cost-effectiveness
- reflecting on the solution to recommend modifying or redeveloping designs or ideas
- reflecting on the effectiveness of procedures used in the design and realisation process
- reflecting on personal learning e.g. project management, practical skills, capabilities
- testing of solution with end point users and recording feedback in written or multimodal form
- collecting feedback from peers or industry evaluation of the solution
- evaluating potential publishing or entrepreneurship opportunities e.g. patents, marketing and distribution, mass production, online publishing, crowd sourcing
- evaluating the ethical, legal, economic and/or sustainability issues related to the product or solution.
CONTEXTS

Stage 1 Design, Technology and Engineering is organised into four contexts: digital communication solutions, industry and entrepreneurial solutions, material solutions and robotic and electronic systems.

The contexts provide opportunities to develop design thinking, to investigate engineering solutions, to develop a plan, realise the solution and evaluate the outcome. The context is chosen by the school to meet student needs and interests, taking into account the resources available.

Each of these contexts: digital communication solutions, industry and entrepreneurial solutions, material solutions and robotic and electronic systems provides a separate enrolment option for students.

Digital Communication Solutions

This context involves using symbols, signs, behaviour, speech, light, images, sound, or other data to design and make products that communicate information. Students produce outcomes that demonstrate the knowledge and skills associated with manipulation of digital communication media.

Examples of contexts for digital solutions include:
- graphics
- multimedia
- photography
- sound
- web design
- film making
- digital animation
- CAD / CAM
- App development.

Industry and Entrepreneurial Solutions

This context involves the designing of solutions to meet industry requirements or to invent an entrepreneurial product that meets a need or solves a problem. This could be achieved using design programs, such as computer aided design, to develop prototypes or products. Students demonstrate knowledge and skills associated with systems, processes and materials appropriate for the prototype and final solution.

Examples of contexts for Industry or entrepreneurial design solutions include:
- architecture
- construction
- transport (e.g. automotive)
- agricultural equipment
- health and aged care equipment
- maritime equipment
- aerospace
Material Solutions
This context involves the use of a diverse range of manufacturing technologies such as tools, machines, and/or systems to create a product using appropriate materials. Students produce outcomes that demonstrate the knowledge and skills associated with using systems, processes, and materials such as metals, plastics, wood, composites, ceramics, textiles, and foods.
Examples of contexts for material solutions include:
- timber
- metals
- jewellery manufacturing
- clothing and textiles
- food
- polymers
- composite materials.

Robotic and Electronic Systems
In this context, students can use a variety of hardware (components) which may be combined with software to design and realise a solution such as a device or system. Students produce outcomes that demonstrate the knowledge and skills associated with using electronic, mechatronic, electrical or pneumatic systems. These can include electronic components, circuit design and assembly, robotic components, programming, wiring, gears, simulation or systems integration.
The solutions could be purely hardware, for example an electronic circuit, or a combination of hardware (components) and software (code).
Examples of contexts for electronic and robotic systems include:
- robotics (building a programmed, autonomous or remote controlled robot)
- electronic systems (including microcontroller boards such as Arduino and Picaxe)
- electronic circuits (Printed Circuit Boards)
- Internet of Things (IoT) – web connected sensors and devices (e.g. NodeMCU, WeMos, Raspberry Pi, etc.)
- electrical systems
- communication systems (e.g. radio telemetry, Bluetooth, etc)
- automated systems (e.g. Programmable Logic Controllers)
- renewable energy systems (e.g. solar, wind, battery storage)
- autonomous vehicles (e.g. model robot cars)
- biomedical engineering
- mechanical systems (e.g. using a variety of gear mechanisms)
- pneumatic, hydraulic, or fluidic systems.
ASSESSMENT SCOPE AND REQUIREMENTS

Assessment at Stage 1 is school based.

EVIDENCE OF LEARNING

The following assessment types enable students to demonstrate their learning in Stage 1 Design, Technology and Engineering:

- Assessment Type 1: Specialised Skills Task
- Assessment Type 2: Design process and solution

For a 10-credit subject, students should provide evidence of their learning through three assessments. Each assessment type should have a weighting of at least 20%. Students undertake:

- two specialised skills tasks
- one design process and solution

For a 20-credit subject, students should provide evidence of their learning through up to 6 assessments. Each assessment type should have a weighting of at least 20%. Students undertake:

- two or more specialised skills tasks
- one or more design process and solution tasks

ASSESSMENT DESIGN CRITERIA

The assessment design criteria are based on the learning requirements and are used by teachers to:

- clarify for the student what they need to learn
- design opportunities for students to provide evidence of their learning at the highest possible level of achievement.

The assessment design criteria consist of specific features that:

- students should demonstrate in their learning
- teachers look for as evidence that students have met the learning requirements.

For this subject the assessment design criteria are:

- Investigation and Analysis
- Design Development and Planning
- Production
- Evaluation
The specific features of these criteria are described below.
The set of assessments, as a whole, must give students opportunities to demonstrate each of the specific features by the completion of study of the subject.

**Investigation and Analysis**
The specific features are as follows:
I1 Review the design features of products, processes, materials, systems and/or production techniques.
I2 Research and analyse ethical, legal, economic and/or sustainability issues.

**Design Development and Planning**
The specific features are as follows:
D1 Communicate design concepts using technical language.
D2 Plan and develop design concepts and procedures.

**Production**
The specific features are as follows:
P1 Application of skills, processes, procedures and techniques to create a solution.
P2 Development of solutions to technical problems that arise during the solution realisation.

**Evaluation**
The specific features are as follows:
E1 Evaluation of the solution features and realisation process.

**SCHOOL ASSESSMENT**

**Assessment Type 1: Specialised Skills Task**
For a 10-credit subject, students undertake one or more specialised skills task. For a 20-credit subject, students undertake at least two specialised skills task.

Students develop knowledge and skills through specialised skills tasks. They apply the skills, processes and techniques in the related context. This informs the design development for a solution in Assessment Type 2. Students evaluate and assess the development of their own skills in this assessment task. They review how these processes and techniques may influence their solution.

Students and teachers negotiate whether it would be appropriate to demonstrate these processes and techniques in a single session, or over a more extended period of time. This assessment could consist of one activity or a series of activities.

This task should be completed in multimodal form to a maximum of three minutes.

Specialised skills may include for example;
- using a wood lathe for turning table legs
- using a laser cutter to make a variety of joints for testing
• experimenting with shutter speed and aperture
• experimenting with green screen
• construction and machine techniques for stretch or fine fabrics
• using yeast as a leavening agent
• preserving techniques for native foods
• experimenting with different materials for stress testing
• experimenting with machine applications for decoration on fabric products.

For this assessment type, students provide evidence of their learning primarily in relation to the following assessment design criteria:

• Production
• Evaluation

**Assessment Type 2: Design process and solution**

For a 10-credit subject, students undertake one design process assessment type. The design process is in two parts.

**Part 1 – Design development**

Students show evidence of key design phases of investigation and analysis, design development and planning. This could be completed individually or as part of a collaborative task.

The evidence for the design development should be a maximum of 1000 words if written or 6 minutes of recorded oral communication, or the equivalent in multimodal form.

**Part 2 – Solution realisation**

Students create and evaluate the solution. The student provides evidence of the solution in the form of images or a video recording and evaluates the completed solution. Students should evaluate how well the requirements of the design brief have been met including what worked well, what did not go according to plan, and what was learnt. Students consider possible modifications to improve the outcome, and discuss how the solution is to be used.

The evidence for the solution realisation should be a maximum of 500 words if written or 3 minutes of recorded oral communication, or the equivalent in multimodal form.

For a 20-credit subject, students create one or more design process tasks. For a 20 credit subject, the combined evidence for Assessment Type 2 should be a maximum of 3000 words if written or a maximum of 18 minutes of recorded oral communication, or the equivalent in multimodal form.
For this assessment type, students provide evidence of their learning primarily in relation to the following assessment design criteria:

- Investigation and Analysis
- Design Development and Planning
- Producing
- Evaluation

**PERFORMANCE STANDARDS**

The performance standards describe five levels of achievement, A to E.

Each level of achievement describes the knowledge, skills, and understanding that teachers refer to in deciding how well students have demonstrated their learning on the basis of the evidence provided.

During the teaching and learning program the teacher gives students feedback on their learning, with reference to the performance standards.

At the student’s completion of study of a subject, the teacher makes a decision about the quality of the student’s learning by:

- referring to the performance standards
- taking into account the weighting of each assessment type
- assigning a subject grade between A and E.
## Performance Standards for Stage 1 Design, Technology and Engineering

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| **A**                      | Comprehensive and thoughtful review of the design features of products, processes, materials, systems and/or production techniques  
Planned and thorough research and analysis of ethical, legal, economic and/or sustainability issues | Polished and comprehensive communication of design concepts using relevant technical language  
Insightful planning and development of design concepts and procedures | Highly proficient application of skills, processes, procedures and techniques to create a solution  
Comprehensive development of solutions to technical problems that arise during the solution realisation | Comprehensive and insightful evaluation of the solution features and realisation process |
| **B**                      | Logical and well-considered review of the design features of products, processes, materials, systems and/or production techniques  
Detailed and considered research and analysis of ethical, legal, economic and/or sustainability issues | Thoughtful and well-considered communication of design concepts using relevant technical language  
Well-considered planning and development of design concepts and procedures | Proficient application of skills, processes, procedures and techniques to create a solution  
Thoughtful development of solutions to technical problems that arise during the solution realisation | Well-informed and detailed evaluation of the solution features and realisation process |
| **C**                      | Informed review of the design features of products, processes, materials, systems and/or production techniques  
Research and discussion of ethical, legal, economic and/or sustainability issues | Clear communication of design concepts using technical language  
Competent planning and development of design concepts and procedures | Competent application of skills, processes, procedures and techniques to create a solution  
Development of solutions to technical problems that arise during the solution realisation | Considered evaluation of the solution features and realisation process |
| **D**                      | Identification of the design features of products, processes, materials, systems and/or production techniques  
Some description of information about ethical, legal, economic and/or sustainability issues | Basic communication of design concepts using some technical language  
Some planning and development of design concepts and/or procedures | Basic application of some skills, processes, procedures and techniques to create a solution  
Some endeavour to develop solutions to technical problems that arise during the solution realisation | Some description of the solution features and realisation process |
| **E**                      | Attempted identification of the design features of products, processes, materials, systems and/or production techniques  
Some accessing of information about ethical, legal, economic and/or sustainability issues | Superficial and simplistic communication of design concepts  
Limited use of information to plan design concepts | Limited application of emerging skills  
Attempted development of a solution to a technical problem | Emerging recognition of the solution features and realisation process |
ASSESSMENT INTEGRITY

The SACE Assuring Assessment Integrity Policy outlines the principles and processes that teachers follow to assure the integrity of student assessments. This policy is available on the SACE website (www.sace.sa.edu.au) as part of the SACE Policy Framework.

The SACE Board uses a range of quality assurance processes so that the grades awarded for student achievement in the school assessment are applied consistently and fairly against the performance standards for a subject, and are comparable across all schools.

Information and guidelines on quality assurance in assessment at Stage 1 are available on the SACE website (www.sace.sa.edu.au).
SUPPORT MATERIALS

SUBJECT-SPECIFIC ADVICE

Online support materials are provided for each subject and updated regularly on the SACE website (www.sace.sa.edu.au). Examples of support materials are sample learning and assessment plans, annotated assessment tasks, annotated student responses, and recommended resource materials.

ADVICE ON ETHICAL STUDY AND RESEARCH

Advice for students and teachers on ethical study and research practices is available in the guidelines on the ethical conduct of research in the SACE, which are on the SACE website (www.sace.sa.edu.au).
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SUBJECT DESCRIPTION

Stage 2 Design, Technology and Engineering is a 20 credit subject.

In Design, Technology and Engineering students use design thinking to engineer solutions for the development of products or systems. Design, Technology and Engineering has four contexts: digital communication solutions, Industry and entrepreneurial solutions, materials solutions and robotic and electronic systems.

The subject provides a flexible framework that encourages students to be creative, innovative and enterprising in their chosen context. They apply critical problem solving skills and incorporate technologies to address design problems and challenges. This subject incorporates the transfer of interdisciplinary skills and knowledge and promotes individualised and inquiry based learning. Design, Technology and Engineering provides opportunities for students to apply engineering processes and use new and evolving technologies.

In Stage 2 Students use an iterative design process to explore possible solutions to a problem or opportunity. They investigate and analyse the purpose, design features, materials and production techniques used in diverse situations including industry, community and tertiary organisations. This information is used to create a design brief that provides the basis for the development of potential solutions. The importance of the design process as a preliminary to the realisation process is emphasised, as is ongoing evaluation of the solution and visa versa.

A solution in this subject is an outcome of the design and realisation process in relation to the chosen context. A solution could be fully realised or a model, prototype, system, part, process (i.e. procedures to output a product) or product

Students analyse influences on a solution including ethical, legal, economic, and/or sustainability issues. They consider the practical implication of these issues on society or design solutions.

Students apply appropriate skills, processes, procedures and techniques whilst implementing safe work practices in the creation of the solution.

Student learning is reported for the following contexts:

- Design, Technology and Engineering — Digital Communication Solutions
- Design, Technology and Engineering — Industry and Entrepreneurial Solutions
- Design, Technology and Engineering — Material Solutions
- Design, Technology and Engineering — Robotic and Electronic Systems
CAPABILITIES
The capabilities connect student learning within and across subjects in a range of contexts.
The SACE identifies seven capabilities. They are:
- literacy
- numeracy
- information and communication technology (ICT) capability
- critical and creative thinking
- personal and social capability
- ethical understanding.
- intercultural understanding.

Literacy
In this subject students extend and apply their literacy capability by, for example:
- using a range of sketches, graphical, digital, or computer-generated images to communicate product or systems design ideas to suit particular contexts and audiences
- understanding and using language and terminology specific to design, technology and engineering in written or oral forms to communicate ideas about solutions design
- understanding and applying specific instructions in relation to systems, processes, and safe operating procedures
- interpreting and analysing technical information
- using a variety of communication formats, including digital technologies to demonstrate understanding and analysis
- using language for different purposes including to interpret, discuss and explain concepts, issues, problems and solutions
- reading and interpreting online documentation and acknowledging resources appropriately

Numeracy
In this subject students extend and apply their numeracy capability by, for example:
- selecting and using appropriate measurement tools and programs
- applying numerical calculations appropriate to the context and task
- displaying numerical information in accordance with technical standards and procedures
- interpreting numerical data for relevance
- understanding and using graphs, spreadsheets, diagrams, codes, and statistics to communicate technical data, properties of materials or systems information
- creating tables, charts or diagrams to define product specifications such as measurement
- applying the scientific method to the design and construction processes of the solution e.g. testing material characteristics or suitability.
Information and communication technology (ICT) capability

In this subject students extend and apply their ICT capability by, for example:

- using relevant digital technologies to communicate design intent
- locating and accessing information using digital technologies
- presenting findings or solutions using multimodal approaches such as a multimodal design brief
- using specialised programs and tools to develop solutions such as Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM)
- understanding the impact of ICT.

Critical and creative thinking

In this subject students extend and apply their critical and creative thinking capability by, for example:

- analysing existing product or system characteristics and features to inform the design and realisation process
- visualising possibilities and scoping solutions
- adapting the design development in response to results of testing and research
- identifying and deconstructing problems
- using initiative in designing products or concept solutions
- evaluating existing and proposed designs of products or systems
- designing innovative, creative, and appropriate solutions using materials available
- critically evaluating entrepreneurial opportunities e.g. patents, marketing and distribution, mass production, online publishing, crowd sourcing.

Personal and social capability

In this subject students extend and apply their personal and social capability by, for example:

- listening to and respecting the perspective of others
- participating in inquiry-based activities that foster problem-solving and practical application skills
- sharing ideas about problems, progress and innovative solutions
- working collaboratively face to face or online to develop imaginative, innovative and enterprising outcomes
- having opportunities to interact with people in different contexts and building the confidence to be involved problem solving
- planning and working in productive, creative, collaborative, and independent ways
- making decisions and taking initiative in designing products or solutions
- acquiring practical skills, knowledge, and understanding related to the design, development and realisation of product or system
- understanding how design affects individual, groups and or society
- developing entrepreneurial skills
• planning effectively and managing time.

Ethical understanding
In this subject students extend and apply their ethical understanding capability by, for example:
• evaluating the reliability of information for accurate decision making
• understanding the ethical implications of environmental responsibility and sustainability through considered selection and use of materials, processes and production techniques
• recognising the importance of responsible participation in social, economic, environmental, scientific and/or ethical decision making
• applying an understanding of personal and group safety in a work environment
• reviewing the impact of technological practices, products, or systems on individuals, society and/or the environment.

Intercultural understanding
In this subject students extend and apply their intercultural understanding capability by, for example:
• understanding that the process of designing and implementing a design solution is influenced by cultural factors
• valuing cultural diversity when working in groups or solving problems
• respecting and engaging with different cultural perspectives, skills and customs, and exploring these using various technologies
• researching different cultural traditions that impact on design concepts
• exploring design issues in local, national, and/or global contexts to expand knowledge of and create solutions for a diverse range of individuals, groups and societies.
ABORIGINAL AND TORRES STRAIT ISLANDER KNOWLEDGE, CULTURES, AND PERSPECTIVES

In partnership with Aboriginal and Torres Strait Islander communities, and schools and school sectors, the SACE Board of South Australia supports the development of high-quality learning and assessment design that respects the diverse knowledge, cultures, and perspectives of Indigenous Australians.

The SACE Board encourages teachers to include Aboriginal and Torres Strait Islander knowledge and perspectives in the design, delivery, and assessment of teaching and learning programs by:

- providing opportunities in SACE subjects for students to learn about Aboriginal and Torres Strait Islander histories, cultures, and contemporary experiences
- recognising and respecting the significant contribution of Aboriginal and Torres Strait Islander peoples to Australian society
- drawing students’ attention to the value of Aboriginal and Torres Strait Islander knowledge and perspectives from the past and the present
- promoting the use of culturally appropriate protocols when engaging with and learning from Aboriginal and Torres Strait Islander peoples and communities.
LEARNING SCOPE AND REQUIREMENTS

LEARNING REQUIREMENTS

The learning requirements summarise the knowledge, skills, and understanding that students are expected to develop and demonstrate through their learning in Stage 2 Design, Technology and Engineering.

In this subject, students engage in the Design and Realisation Process and are expected to:

1. investigate and analyse design features, processes, materials, and production techniques and apply creative thinking to the design of a solution
2. plan, develop and test design concepts and communicate potential features and solutions to a problem or challenge
3. apply knowledge and understanding of skills, processes, engineering procedures, and techniques using technology to realise the solution
4. evaluate the solution with reference to the design brief and reflect on processes used in design development and realisation
5. analyse ethical, legal, economic and/or sustainability issues related to technology, materials selected, processes used and/or solution design.
CONTENT

The Design and Realisation Process

The design and realisation process is a flexible framework and forms the structure of the subject. The following are components of a coherent and dynamic design progression. This process is rarely linear, and designing should be seen as cyclical with many possible solutions, rather than a simple step by step process.

A diagram to show the design process.
Investigating and Analysis

The design and realisation process should begin with the identification of a problem or opportunity followed by an initial investigation and research analysis. The creation of a design brief must specify constraints, considerations and propose creative and innovative solutions. Students define criteria to evaluate how well the finished product meets the requirements of the design brief.

Possible investigation and analysis strategies or techniques may include, for example:

- use creative thinking techniques e.g. visualization, lateral thinking, brainstorming to find the problem and seek solutions
- collaborate using visual tools e.g. mind mapping to explore concepts, problems or opportunities
- investigating and interpreting product design factors or issues such as
  - technologies: tools, processes and manufacturing methods
  - materials: characteristics and properties
  - innovation and creativity- inventing or improving products
  - sustainability: life cycle analysis, carbon footprint, potential to reuse or recycle, fair trade, customs, carbon footprint
  - target audience, end user and potential for entrepreneurship and marketing
  - ethical use and application of the end product
  - ethical concerns related to health and safety, discrimination, social media, advertising, data, images, conflicts of interest,
  - historical and cultural influences including social trends, the changing nature of work, technological change
  - legal responsibilities- patents, safety requirements, intellectual property, creative commons, Australian International Standard, regulations and legislation including OH&S, safety of the product for the user
  - economic considerations: costing of products including materials, labour and equipment and machinery, responsible use of resources, products built to last, time management and material availability
- creating a written or multimodal design brief that includes key criteria and/or constraints such as function and/or aesthetics
- analysing existing product or system characteristics and features to inform the design and realisation process
- collecting and analysing data from a target audience e.g. survey, questionnaire
- researching and analysing information from different contexts such as the manufacturing sector or emerging advanced technologies
- researching historical design or period influences or different cultural traditions
- acknowledging and correctly referencing sources of information and ideas
- conducting peer review and feedback about the design brief
- critically analysing sources of information for reliability and validity.
Design Development and Planning

Another component of the design and realisation process is design development and planning in response to an established brief. This involves innovation, invention, iteration and creativity to develop a solution for an opportunity or unsolved problem. Students document their design ideas and make plans to use the available resources such as time, materials and technologies to realise the solution. They test, adapt and validate the design prior to realisation.

Possible design development and planning strategies or techniques may include, for example:

- use ideation strategies such as adapting, modifying, substituting or rearranging to improve the solution
- creating a design brief showing specific aspects of the design development and planning
- creating working drawings, concept sketches, prototypes, storyboards, flow charts, simulation or 3D modelling.
- working collaboratively face to face or online to develop imaginative, innovative, and enterprising outcomes e.g. with peers, industry, tertiary education or community
- applying interdisciplinary concepts e.g. artistic, scientific, mathematical and engineering skills appropriate to the planning and designing of the product or system
- preparing timelines and procedures using visual organisers such as Gantt charts and tables showing sequencing
- testing and recording (e.g. photo essay, video, result tables, annotated images) possible materials and processes through experimentation, trial and error or applying secondary research
- collection of qualitative and quantitative data using scientific methodologies
- adapting the design development in response to results of testing and research
- justifying design solutions based on investigations and research analysis
- preparing a table, chart or diagram to define product specifications e.g. measurement, materials to be used, processes required
- applying the scientific method to the design and construction processes of the product or system e.g. testing material characteristics or suitability
- using relevant digital technologies to communicate design intent.

Solution realisation

This component (stage) of the design and realisation process involves realising a solution. A solution is the outcome of applying technological skills to meet the requirements of a design and realisation brief.

A solution in this subject is an outcome of the design and realisation process in relation to the chosen context. A solution could be fully realised or a model, prototype, system, part, process (i.e. procedures to output a product) or product.

Possible solution realisation strategies or techniques may include, for example:

- production of a solution captured in multimodal form e.g. photo story or short film
- using appropriate processes and production techniques
- creating solutions to the planned design specifications
• developing skills and applying them to a range of applications
• create an annotated multimodal product record of the creation of the product
• developing solutions to technical and engineering problems that may arise such as accuracy of machinery, quality of materials and components, understanding of software programs
• apply appropriate safety processes including physical and online environments.

Evaluation
The final component of the design and realisation process is evaluation. Evaluation involves judging the quality of the product against the criteria specified in the design brief and recommending improvements
Possible evaluation strategies or techniques may include, for example:
• evaluating, individually and/or collaboratively, how effectively the requirements of the design brief specifications have been met
• reviewing criteria, standards, reliability, safety, quality, and cost-effectiveness
• reflecting on product or system outcomes to recommend modifying or redeveloping designs or ideas
• reflecting on the effectiveness of procedures used in the design and realisation process
• reflecting on personal learning e.g. project management, practical skills, capabilities
• testing of product or system with end point users and recording feedback in written or multimodal form
• collecting feedback from peers or industry evaluation of solution
• creating a weekly journal to record the on-going evaluation of the process and product
• evaluating potential publishing or entrepreneurship opportunities e.g. patents, marketing and distribution, mass production, online publishing, crowd sourcing.
CONTEXTS

Stage 2 Design, Technology and Engineering is organised into four contexts: digital communication solutions, industry and entrepreneurial solutions, material solutions and robotic and electronic systems.

The contexts provide opportunities to develop design thinking, to investigate engineering solutions, to develop a plan, realise the solution and evaluate the outcome. The context is chosen by the school to meet student needs and interests, taking into account the resources available.

Each of these contexts: digital communication solutions, industry and entrepreneurial solutions, material solutions and robotic and electronic systems provides a separate enrolment option for students.

Digital Communication Solutions

This context involves using symbols, signs, behaviour, speech, light, images, sound, or other data to design and make products that communicate information. Students produce outcomes that demonstrate the knowledge and skills associated with manipulation of digital communication media.

Examples of contexts for digital solutions include:
- advanced manufacturing programs (e.g. CADCAM)
- graphics
- multimedia
- photography
- sound
- web design
- film making
- digital animation
- App development.

Industry or Entrepreneurial Design Solutions

This context involves the designing of solutions to meet industry requirements or to invent an entrepreneurial product that meets a need or solves a problem. This could be achieved using design programs, such as computer aided design, to develop prototypes or products. Students demonstrate knowledge and skills associated with systems, processes and materials appropriate for the prototype and final solution.

Examples of contexts for Industry or entrepreneurial design solutions include:
- architecture
- construction
- transport (e.g. automotive)
- agricultural equipment
- health and aged care equipment
- maritime equipment
- aerospace
• food industry
• product design
• media, entertainment and music industries.

Material Solutions
This context involves the use of a diverse range of manufacturing technologies such as tools, machines, and/or systems to create a product using appropriate materials. Students produce outcomes that demonstrate the knowledge and skills associated with using systems, processes, and materials such as metals, plastics, wood, composites, ceramics, textiles, and foods.

Examples of contexts for material solutions include:
• timber
• metals
• jewellery manufacturing
• clothing and textiles
• food
• polymers
• composite materials.

Robotic and Electronic Systems
In this context, students can use a variety of hardware (components) which may be combined with software to design and realise a solution such as a device or system. Students produce outcomes that demonstrate the knowledge and skills associated with using electronic, mechatronic, electrical or pneumatic systems. These can include electronic components; circuit design and assembly, robotic components, programming, wiring, gears, simulation or systems integration.

The solutions could be purely hardware, for example an electronic circuit, or a combination of hardware (components) and software (code).

Examples of contexts for electronic and robotic systems include:
• robotics (building a programmed, autonomous or remote controlled robot)
• electronic systems (including microcontroller boards such as Arduino and Picaxe)
• electronic circuits (Printed Circuit Boards)
• Internet of Things (IoT) – web connected sensors and devices (e.g. NodeMCU, WeMos, Raspberry Pi, etc.)
• electrical systems
• communication systems (e.g. radio telemetry, Bluetooth, etc)
• automated systems (e.g. Programmable Logic Controllers)
• renewable energy systems (e.g. solar, wind, battery storage)
• autonomous vehicles (e.g. model robot cars)
• biomedical engineering
• mechanical systems (e.g. using a variety of gear mechanisms)
• pneumatic, hydraulic, or fluidic systems.
ASSESSMENT SCOPE AND REQUIREMENTS

All Stage 2 subjects have a school assessment component and an external assessment component.

EVIDENCE OF LEARNING
The following assessment types enable students to demonstrate their learning in Stage 2 Design, Technology and Engineering.

School assessment (70%)
- Assessment Type 1: Specialised Skills Task (20%)
- Assessment Type 2: Design Process and Solution (50%)

External assessment (30%)
- Assessment Type 3: Resource Study (30%)

Students provide evidence of their learning through four to six assessments, including the external assessment component. Students complete:
- two specialised skills tasks
- up to three design process and solution tasks
- one resource study.

ASSESSMENT DESIGN CRITERIA
The assessment design criteria are based on the learning requirements and are used by:
- teachers to clarify for the student what they need to learn
- teachers and assessors to design opportunities for students to provide evidence of their learning at the highest possible level of achievement.

The assessment design criteria consist of specific features that:
- students should demonstrate in their learning
- teachers and assessors look for as evidence that students have met the learning requirements.

For this subject the assessment design criteria are:
- Investigation and Analysis
- Design Development and Planning
- Production
- Evaluation

The specific features of these criteria are described below.
The set of assessments, as a whole, must give students opportunities to demonstrate each of the specific features by the completion of study of the subject.

**Investigation and Analysis**

The specific features are as follows:

I1  Analyse the design features of products, processes, materials, systems and/or production techniques.

I2  Analyse ethical, legal, economic and/or sustainability issues related to a solution.

**Design Development and Planning**

The specific features are as follows:

D1  Communicate design concepts using technical language and visual representations.

D2  Plan, develop, test and validate concepts and procedures.

**Production**

The specific features are as follows:

P1  Application of skills, processes, procedures and techniques to create a solution.

P2  Development of solutions to technical problems or recommendations for improvement.

**Evaluation**

The specific features are as follows:

E1  Evaluation of the solution features and realisation process.
SCHOOL ASSESSMENT

Assessment Type 1: Specialised skills task (20%)

Students complete two specialised skills tasks. They demonstrate skills and knowledge that will be required for the realisation of their solution. Tasks may be scaffolded providing explicit guidance for students or can be student developed. Students and teachers may negotiate whether it would be appropriate to demonstrate these skills in a single session, or over a more extended period of time.

Students develop knowledge and skills through specialised skills tasks. They apply the skills, processes and techniques in the chosen context. This informs the design development for a solution in Assessment Type 2. Students evaluate and assess the development of their own skills in this assessment task. They review how these processes and techniques may influence their solution.

Evidence for this assessment type should be provided in multimodal form to a maximum of 6 minutes, 1000 words in written form or a combination of these.

Specialised skills may include for example:

- A simple circuit, such as an Arduino with a single input and output
- Conducting a finite element analysis test using a CAD program
- Programming a profile cut for a plasma cutter
- Programming a hit test collision for a game application
- Using specialised equipment to decorate by embellishing products
- Creating food products using molecular science strategies.

For this assessment type, students provide evidence of their learning primarily in relation to the following assessment design criteria:

- Production
- Evaluation
Assessment Type 2: Design Process and Solution (50%)

Students produce up to three tasks in the design process and solution assessment type that together provide evidence of the stages of the Design and Realisation Process. There is flexibility in this assessment type for a single assessment task to be completed or a series of up to three smaller, discrete.

The Design and Realisation Process task(s) may include examples selected from those listed in the content section under the Design and Realisation Process heading (page 32-34).

The task(s) should be up to a total maximum of 2000 words or the equivalent in multimodal form where 6 minutes is equivalent to 1000 words. The task must showcase and evaluate the solution or product.

For this assessment type, students provide evidence of their learning primarily in relation to the following assessment design criteria:

- Investigation and Analysis
- Design Development and Planning
- Production
- Evaluation
EXTERNAL ASSESSMENT

Assessment Type 3: Resource Study (30%)

Students undertake one Resource Study comprising of two parts.

Part One: Resource Investigation

Students investigate and analyse the functional characteristics and properties of two or more materials or components they are considering for use in the creation of their solution. They report on how their research into and testing of the functional characteristics and properties of these materials or components will affect their selection for use in the realisation of their solution.

The specific features of the assessment design criteria assessed in this part are:
- Investigation and Analysis 1 (I1)
- Design Development and Planning 2 (D2)

Part Two: Issue Exploration

Students investigate and analyse ethical, legal, economic and/or sustainability issues related to their solution.

The specific features of the assessment design criteria assessed in this part are:
- Investigation and Analysis 2 (I2)
- Evaluation (E1)

The Resource Study should be presented in written or multimodal form or a combination of both. It should be up to a maximum of 2000 words if written or the equivalent in multimodal form, where 1000 words is equivalent to 6 minutes.

The following specific features of the assessment design criteria for this subject are assessed in the Resource Study:
- Investigation and Analysis
- Design Development and Planning (D2)
- Evaluation
PERFORMANCE STANDARDS
The performance standards describe five levels of achievement, A to E.

Each level of achievement describes the knowledge, skills, and understanding that teachers and assessors refer to in deciding how well students have demonstrated their learning on the basis of the evidence provided.

During the teaching and learning program the teacher gives students feedback on their learning, with reference to the performance standards.

The student’s school assessment and external assessment are combined for a final result, which is reported as a grade between A+ and E−.
### Performance Standards for Stage 2 Design, Technology and Engineering

<table>
<thead>
<tr>
<th>Investigation and Analysis</th>
<th>Design Development and Planning</th>
<th>Production</th>
<th>Evaluation</th>
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</table>
| **A**                      | Comprehensive and insightful analysis of the design features of products, processes, materials, systems and/or production techniques  
Purposeful research and critical analysis of ethical, legal, economic and/or sustainability issues |
|                            | Insightful and comprehensive communication of design concepts using relevant technical language and visual representations  
Insightful and thorough planning, development, testing and validation of design concepts and procedures |
|                            | Highly proficient application of skills, processes, procedures and techniques to create a solution  
Comprehensive development of solutions to technical problems that arise during the solution realisation |
|                            | Comprehensive and insightful evaluation of the solution features and realisation process |
| **B**                      | Thoughtful and well-considered analysis of the design features of products, processes, materials, systems and/or production techniques  
Detailed research and well-considered discussion of ethical, legal, economic and/or sustainability issues |
|                            | Thoughtful and well-considered communication of design concepts using relevant technical language and visual representations  
Well-considered planning, development, testing and validation of design concepts and procedures |
|                            | Proficient application of skills, processes, procedures and techniques to create a solution  
Thoughtful development of solutions to technical problems that arise during the solution realisation |
|                            | Well-informed and detailed evaluation of the solution features and realisation process |
| **C**                      | Considered analysis of the design features of products, processes, materials, systems and/or production techniques  
Research and some analysis of ethical, legal, economic and/or sustainability issues |
|                            | Clear communication of design concepts using technical language and some visual representations  
Competent planning, development, testing and validation of some design concepts and procedures |
|                            | Competent application of skills, processes, procedures and techniques to create a solution  
Development of solutions to technical problems that arise during the solution realisation |
|                            | Considered evaluation of the solution features and realisation process |
| **D**                      | Identification of the design features of products, processes, materials, systems and/or production techniques  
Some description of information about ethical, legal, economic and/or sustainability issues |
|                            | Basic communication of design concepts using some technical language  
Some planning and development of design concepts and/or procedures |
|                            | Basic application of some skills, processes, procedures and techniques to create a solution  
Some endeavour to develop solutions to technical problems that arise during the solution realisation |
|                            | Some description of the solution features and realisation process |
| **E**                      | Attempted identification of the design features of products, processes, materials, systems and/or production techniques  
Some accessing of information about ethical, legal, economic and/or sustainability issues |
|                            | Superficial and simplistic communication of design concepts  
Limited use of information to plan design concepts |
|                            | Limited application of emerging skills  
Attempted development of a solution to a technical problem |
|                            | Emerging recognition of the solution features and realisation process |
ASSESSMENT INTEGRITY

The SACE Assuring Assessment Integrity Policy outlines the principles and processes that teachers and assessors follow to assure the integrity of student assessments. This policy is available on the SACE website (www.sace.sa.edu.au) as part of the SACE Policy Framework.

The SACE Board uses a range of quality assurance processes so that the grades awarded for student achievement, in both the school assessment and the external assessment, are applied consistently and fairly against the performance standards for a subject, and are comparable across all schools.

Information and guidelines on quality assurance in assessment at Stage 2 are available on the SACE website (www.sace.sa.edu.au).
SUPPORT MATERIALS

SUBJECT-SPECIFIC ADVICE
Online support materials are provided for each subject and updated regularly on the SACE website (www.sace.sa.edu.au). Examples of support materials are sample learning and assessment plans, annotated assessment tasks, annotated student responses, and recommended resource materials.

ADVICE ON ETHICAL STUDY AND RESEARCH
Advice for students and teachers on ethical study and research practices is available in the guidelines on the ethical conduct of research in the SACE, which are on the SACE website (www.sace.sa.edu.au).