Singapore Examinations and Assessment Board

Cambridge Assessment International Education

Singapore–Cambridge General Certificate of Education Ordinary Level (2022)

Design and Technology (Syllabus 7059)

CONTENTS

INTRODUCTION

This Design & Technology (D&T) syllabus is designed to engage students in designing and prototyping ideas through applying technology. The students' learning leverages and builds on their experiences in design and technology, and emphasises on understanding everyday activities and creating possibilities to make life better. Through the design process, students cultivate creative, critical and reflective thinking to make sense of their learning and to develop related dispositions and skills using graphical means and technology.

AIMS

The following aims of the syllabus describe the educational intent of D&T. They guide and influence the syllabus implementation and are not listed in order of priority. The aims of the D&T syllabus are to enable students to:

- develop confidence, pride and tenacity through exploring real-world design opportunities for which ideas are developed
- develop the quality of mindfulness, empathy and sensitivity through improving aspects of their environment in everyday life
- embrace complexities, uncertainties and the inherent social dimension of the design process when exploring design opportunity vis-à-vis design ideas
- cultivate thinking through doodling and sketching/drawing
- experiment and prototype ideas using appropriate materials and tools
- build on their innate curiosity and ability to create
- exercise judgements and make evidence-based decisions of a technological, aesthetic and economic nature.

In achieving the aims, students also develop safe working habits.

ASSESSMENT OBJECTIVES

The three assessment domains in D&T are:

A Knowledge with understanding

B Design thinking skills

C Design manipulating skills

The assessment objectives of each domain are designed to reflect the syllabus aims and to act as the reference to measure candidates' achievement. The objectives state that candidates should be able to:

A KNOWLEDGE WITH UNDERSTANDING

1 demonstrate their ability to apply knowledge in design and technology through designing and prototyping

2 demonstrate their understanding of the nature of the design process

3 plan and manage their project and ensure completion within the given timeframe

B DESIGN THINKING SKILLS

4 detect, frame and understand everyday needs for design opportunities

5 generate tentative ideas through inquiry leading to the proposed design solution

6 analyse and synthesise relevant knowledge and information (in the areas of user, functionality, aesthetics, technology, economics, culture and environment) for informed design decision making

C DESIGN MANIPULATING SKILLS

7 sketch to work towards the proposed design solution

8 build mock-up(s) to explore and/or test ideas for decision making

9 work with appropriate technology for prototyping towards the proposed design solution.

SCHEME OF ASSESSMENT

The assessment domains are weighted to give an indication of their relative importance. They are not intended to provide a precise statement on the number of marks allocated to a particular assessment domain.

Paper	Duration	Assessment Domains			Total
		A Knowledge with Understanding	B Design Thinking Skills	C Design Manipulating Skills	
1 Written Examination	2 hours	25%	10%	5%	40%
2 Design Project	22 weeks	15%	20%	25%	60%
Overall		40%	30%	30%	100%

SUBJECT CONTENT

Section 1 and Section 2 define a content baseline for Centres to provide designing and prototyping opportunities via the Design Process for candidates to:

- develop design-related dispositions
- acquire design techniques and strategies
- consolidate a sound working knowledge of technology (materials, workshop processes, structures, mechanisms and electronics).

The Design Process is the principal process for immersive learning and a unifying platform for candidates to make meaning of their learning. It allows manifestation of knowledge with understanding through the application of design thinking and manipulating skills.

Design Process

Designing is concerned with creating change to affect empathy, practicality and appropriateness in everyday life. As a way of thinking and doing, it focuses on creating solutions using appropriate technology with purposeful intent. This broadly involves rational thought processes and intuitive responses that are nested within a holistic fabric of analytical, creative and critical thinking.

For this examination, candidates investigate and explore daily activities for design opportunities and take ideas from conception to fruition. The process undertaken may be diverse but each should include Needs Analysis, Idea Conceptualisation, Development and Prototyping, all supported by Research to arrive at the proposed design solution. A model to help candidates engage in the design process is shown in Figure 1.

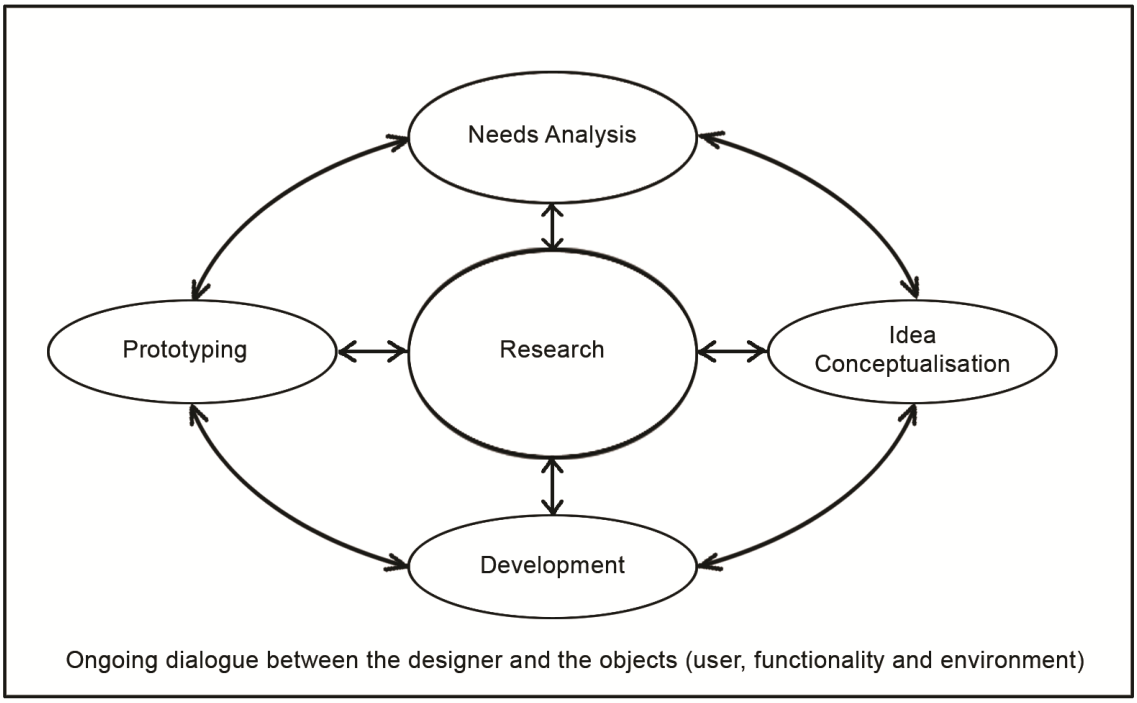

Figure 1: The Design Model

The arrows show that designing is not always a linear process and that it is dynamic in nature requiring frequent and careful looping back to other stages in a holistic manner. For example, when seeking a design opportunity based on observation in Needs Analysis, further investigative research may be needed to justify the need in the opportunity. In another example where emergent problems pose difficulty in fulfilling the intended purpose during Development, reconsideration of the need identified and previous ideas may be necessary. In managing the dynamism of the design process, candidates also carry out ongoing evaluation and refinement of their thought processes. This reflects the ongoing dialogue between the candidate and the objects (user, functionality and environment) of the design situation, which is crucial to the successful execution of any design outcome.

Essential to designing is the ability to imagine and model using doodles/sketches/drawings and mock-ups. These means of modelling ideas also trigger and inform thought processes for experimenting and testing the feasibility of solutions and to help in decision making. Upon thorough and thoughtful development of the idea, the proposed design solution is realised through prototyping. This involves working with suitable resistant materials using workshop processes, and practical application of knowledge in structures, mechanisms and/or electronics. During Prototyping, evaluation and refinement of the proposed design solution should not be ruled out with the aim of achieving a practical and appropriate solution for the identified user.

SECTION 1 DESIGN

Candidates should be able to:		Content
1 2 3	plan for a project taking into consideration the stages of work and resources required monitor and, where necessary, make adjustments to the plan to ensure the completion of the project within a given timeframe produce sub-plans for specific activities for each stage of work	Gantt chart, flow chart
4	use various sources for gathering relevant data	print materials, Internet, interviews, surveys, observations
5	apply analysis techniques using appropriate means like products or visuals/images	PIES analysis, product analysis, user analysis, PMI, SWOT analysis
6	construct guiding questions for investigation and exploration	5W1H
7 8	present data from investigative research interpret data for decision making	diagrams, flowcharts, graphs, test results
9	consider the range of human needs for decision making	social, culture, economics, sustainability
10	formulate a design brief based on a design opportunity	design brief
11	formulate design specifications based on the considerations and constraints of the design brief	design specifications
12	apply ideation techniques to generate ideas	brainstorming, SCAMPER, shape borrowing, attribute listing
13	apply the principles of ergonomics and anthropometric data	ergonomics, anthropometric data
14 15 16	apply appropriate means to ideate and develop ideas refine design ideas through testing and evaluation test and evaluate feasibility of ideas	2D and 3D freehand sketches, mock-ups, prototypes
17	apply the concept of basic drawing techniques to communicate details for prototyping and the proposed design solution	isometric drawing, perspective drawing, orthographic projection drawing, exploded and sectional views, presentation drawing, working drawing, materials list
18	apply the concept of design elements and design principles	line, shape, form, colour, texture, balance, proportion, contrast and emphasis
19	explain the relationship between design and technology	the evolution of mobile phone, personal computers, lighting
20	explain the responsibilities of designers in relation to society and the environment	social design, sustainable design

SECTION 2 TECHNOLOGY

Candidates should be able to:		Content
21	use appropriate materials to build mock-ups	objects, paper, cardboard, foam board
22	show working knowledge of plastics and its uses	thermoplastics: nylon, polythene, polyvinyl chloride, polypropylene, acrylic, polystyrene; thermosets: polyester resin including G.R.P., melamine, urea formaldehyde and phenol formaldehyde
23	show working knowledge of wood and its uses	natural timber: jelutong, meranti, pine; processed wood: plywood, MDF boards, veneer
24	show working knowledge of metal and its uses	ferrous metal: mild steel and high carbon steels; non-ferrous metal: aluminium and the alloy duralumin, copper and its alloys (brass, bronze and pewter), zinc, lead and tin
25	explore materials for their properties and implications of their use in terms of cost, aesthetics, emotive response and sustainability	toughness, durability, stiffness, strength, hardness, elasticity
26	analyse everyday products in relation to forces	tension, compression, bending, torsion, shear
27	explore structural strengthening for stability and rigidity	folds, gussets, ribs, braces, laminating
28	explain the application of control systems in everyday products	open-loop system: thermometer, table lamp, stapler, can opener; closed-loop system: hot water dispenser, water cistern, air conditioner
29	consider the components of a control system in relation to user interface and functionality	input, process, output, feedback
30	adapt available electronic kits for practical application with working knowledge of the electronic components involved	counting, sensing of light, moisture and temperature
31	adapt simple mechanisms involving motion transmission, conversion and control for practical application	levers, linkages, screw, rack and pinion, pulley, cams, gears, springs
32	carry out measuring and marking out processes appropriate to the selected resistant material in a safe manner	datum referencing, measuring, scribing, gauging, marking centres for drilling
33	carry out shaping processes appropriate to the selected resistant material in a safe manner	sawing, filing, planing, snipping, chiselling, drilling, boring, thread cutting, countersinking, bending metals, thermoforming, lathe turning, milling
34	carry out joining and assembling processes appropriate to the selected resistant material in a safe manner	use of jigs and formers, adhesives, nailing, screwing, joining wood (butt, dowelled, mitre, housing), joining metal (bolts and nuts, machine screws, rivets, solder, welding rods), joining plastics (solvent, cement), hinges, knock-down fittings
35	carry out finishing processes appropriate to the selected resistant material in a safe manner	cleaning up, polishing, staining, painting, plastics coating

THE EXAMINATION

Paper 1 **Written Examination (2 hours)**
[40% of the total mark for the subject.]

Candidates are to answer **all** questions. The questions will be design-centric. Question 1 requires knowledge application of Section 1 Design. Question 2 to Question 4 require knowledge application of Section 2 Technology; specifically structures, mechanisms and electronics. The mark allocation is:

Question 1	26 out of 80 marks
Question 2 – 4	54 out of 80 marks

Paper 2 **Design Project (22 weeks)**
[60% of the total mark for the subject.]

The Design Project is an individual coursework-based examination. The examination will be conducted over **22** weeks from the question paper release, excluding school holidays. Candidates will be required to work on a design and prototyping project based on the examination question. For projects that require further research and specialisation beyond the syllabus content, Centres should ensure that this extended learning is within the candidates' means.

The Design Project will comprise two components: The Design Journal and Presentation Board.

The Design Journal is a real-time document that reflects the candidate's attempt at managing his or her personal design process. It should contain design sheets showing the use of:

- a time-stages plan such as a Gantt chart and sub-plans for advancing the project
- information and images, doodles/sketches/drawings (rendered if necessary) and calculations for identifying design opportunity leading to the formulation of the design brief and design specifications, initiating a suitable design idea, and developing the design idea into a working prototype to arrive at a proposed design solution. Use notes and annotations only if necessary.

Candidates are advised not to re-work any design sheet.

Mock-up(s) and the resulting prototype are to be submitted as part of the journal.

Format:

- A3-size sheets that are securely fastened or A3-size sketch pads
- mock-up(s)
- prototype
- mould/jig/former (if any)

The Presentation Board is to communicate succinctly the proposed design solution in relation to the design brief and design specifications. It should show the functional and aesthetic details using appropriate graphical skills to highlight the practicality and appropriateness of the proposed design solution.

Format:

- A2-size board, single-side, two pieces maximum

ASSESSMENT OF PAPER 2 (DESIGN PROJECT)

The Design Project is marked internally and moderated externally based on the Assessment Rubrics on Pages 9 and 10.

The teachers as Coursework Supervisors are to facilitate and assess the Design Project. They are not precluded from acting as advisers to their candidates. The assessment should reflect holistically:

- the candidate's management of the project within the given timeframe
- the quality of the candidate's design and prototyping process to arrive at the proposed design solution in relation to the design brief and design specifications based on the given examination question
- the quality of the proposed design solution in relation to the design brief and design specifications.

The following guidance is intended to assist teachers in the assessment of the Design Project:

Criteria	Candidates should
Planning for and monitoring of the Design Project	• produce a time-stages plan for their design project based on the given timeframe. The plan is to be used for monitoring progress in real time and for producing sub-plans to ensure project completion within the timeframe.
Formulating design brief and design specifications	• investigate and explore daily activities for a design opportunity by analysing research information and using evidence to formulate their design brief and design specifications. They should restate their design brief and design specifications as they gain knowledge of the identified design need.
Generating and developing ideas	• generate and develop ideas based on the user, functionality and environment to arrive at a practical and appropriate proposed design solution. The proposed design solution should be coherent in addressing the design brief and design specifications.
Sketching and drawing to design	• sketch and draw to generate ideas in response to the design opportunity. The sketches and drawings should show idea generation and development leading to the proposed design solution.
Using mock-up(s) to design	• build mock-up(s) to explore and/or test ideas for decision-making. Materials used for building the mock-up(s) may be an assortment of paper, cardboard, foam board, bottle caps and strings.
Communicating the proposed design solution	• communicate their proposed design solution in its contextual use by graphical means on the Presentation Board (PB). This should include highlighting the design features to illustrate its practicality and appropriateness in relation to the user and the environment. The design brief and design specifications should also be stated on the PB.
Realising the prototype	• realise a prototype to show how the proposed design solution works using appropriate technology as described in the syllabus.

ASSESSMENT RUBRICS FOR PAPER 2 DESIGN PROJECT [Total 60 marks]

Criteria (max. mark)	Level 0	Level 1	Level 2	Level 3	Level 4
Planning for and monitoring of the Design Project	No evidence of planning for and monitoring of the design project.	Plan shows main design stages with cursory monitoring of progress by indicating the time taken for each design stage.	Plan shows main design stages with monitoring in the form of sub-plans that are unclear or superficial to guide progress.	Plan shows main design stages with monitoring in the form of sub-plans that are appropriate to guide progress.	Plan shows main design stages with monitoring in the form of sub-plans based on meaningful evaluation of work done to guide progress.
(4)	0	1	2	3	4
Formulating design brief and design specifications	No investigation carried out, no design brief and design specifications stated.	Investigation carried out on the design opportunity provides little or no evidence, leading to the weak set of design brief and design specifications formulated.	Investigation carried out on the design opportunity provides obvious evidence, leading to the superficial set of design brief and design specifications formulated.	Relevant investigative work carried out on the design opportunity provides credible evidence, leading to the clear set of design brief and design specifications formulated.	Incisive investigative work carried out on the design opportunity provides compelling evidence, leading to the meaningful set of design brief and design specifications formulated.
(10)	0	1 – 2	3 – 5	6 – 8	9 – 10
Generating and developing ideas	No evidence of generating and developing ideas.	Little or no consideration of the user, functionality and environment when generating and developing ideas for the design opportunity. The process is cursory.	General consideration of the user, functionality and the environment when generating and developing ideas for the design opportunity. The process is basic.	Appropriate consideration of the user, functionality and the environment in relation to the design opportunity The idea generation and development process is reasonable and adequate.	User, functionality and the environment in relation to the design opportunity are well considered and precise. The idea generation and development process is thorough and thoughtful.
(14)	0	1 – 3	4 – 7	8 – 11	12 – 14
Sketching and drawing to design	No sketch and drawing.	Sketches and drawings are rarely used to trigger, visualise and develop ideas, and work out details for prototyping.	Sketches and drawings are occasionally used to trigger, visualise and develop ideas, and work out details for prototyping.	Sketches and drawings are frequently used to trigger, visualise and develop ideas, and work out details for prototyping.	Sketches and drawings are consistently used to trigger, visualise and develop ideas, and work out details for prototyping.
(6)	0	1	2 – 3	4 – 5	6
Using mock-up(s) to design	No evidence of using mock-up(s).	Mock-up(s) has limited purpose.	Mock-up(s) is superficial with tenuous links to development.	Mock-up(s) is meaningful, assisting in the development of design ideas.	Mock-up(s) is purposeful, leading to insightful decision-making in the development of design ideas.
(6)	0	1	2 – 3	4 – 5	6

Criteria (max. mark)	Level 0	Level 1	Level 2	Level 3	Level 4
Communicating the proposed design solution	No Presentation Board submitted.	Communication of the proposed design solution is inconclusive. Illustrations are vague in showing how the solution would function as intended.	Communication of the proposed design solution is plausible. Illustrations more or less show how the solution would function as intended.	Communication of the proposed design solution is clear. Illustrations are adequate in showing how the solution would function as intended.	Communication of the proposed design solution is convincing. Illustrations are detailed to show clearly how the solution would function as intended.
(8)	0	1 – 2	3 – 4	5 – 6	7 – 8
Realising the prototype	No prototype submitted.	Prototype is incomplete or reflects poor making skills. Limited quality control has resulted in minimal level of accuracy and an outcome that barely functions.	Prototype reflects fair making skills. Average quality control has resulted in few inaccuracies and functions more or less as intended.	Prototype reflects competent making skills. Adequate quality control has resulted in an outcome that functions as intended.	Prototype reflects proficient making skills. Attention to details has resulted in an outcome that meets fully the intended requirements.
(12)	0	1 – 3	4 – 6	7 – 9	10 – 12