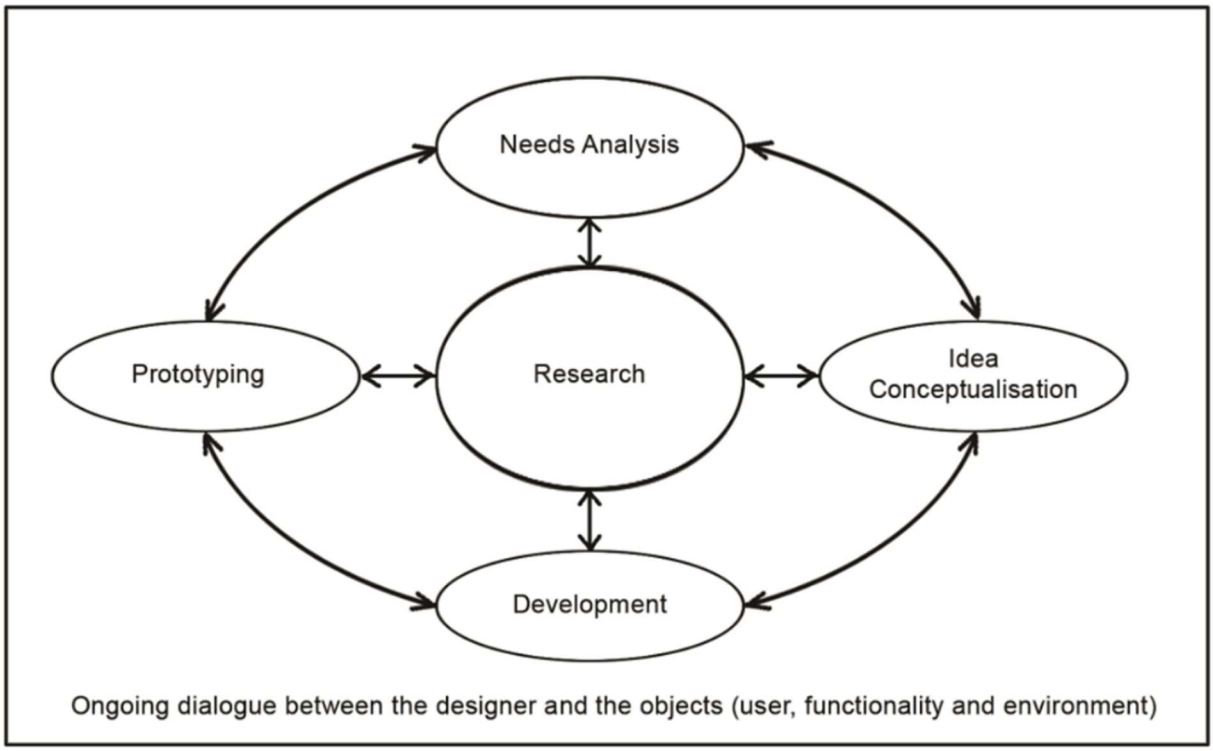
Learning Objectives (from 7059_y25_sy.pdf – D&T Syllabus)

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	present data from investigative research	diagrams, flowcharts, graphs, test results
8	interpret data for decision making	
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	apply appropriate means to ideate and develop ideas	2D and 3D freehand sketches, mock-ups, prototypes
15	refine design ideas through testing and evaluation	
16	test and evaluate feasibility of ideas	
20	explain the responsibilities of designers in relation to society and the environment	social design, sustainable design
21	use appropriate materials to build mock-ups	objects, paper, cardboard, foam board

The Design Model



D&T – Design

Identifying Needs

PIES Technique

- **P**hysical needs
- **I**ntellectual needs
- **E**motional needs
- **S**ocial needs

Mind mapping

- Structure thoughts on paper, showing links between them
- Use to analyse theme

5W1H Technique

- **W**ho – affected?
- **W**hat – problem?
- **W**hen – period & duration where problem occurs?
- **W**here – problem found at where?
- **W**hy – critical that problem is solved?
- **H**ow – did problem emerge in the first place / circumstances?

Problem Situation

- 5W1H
    - **W**ho – target user
    - **W**hat – potential problem
    - **W**here – location carried out
    - **W**hy – reasons that lead to problem
    - **W**hen – time/period when problem occurs.
- Read the question, might already be already stated there.

Design Brief

- To design and make a **product**, for the **user/people** at **place** to **solve the problem/function**.

D&T – Design

Design Specifications

- List of attributes of the product
- Directly influenced by design considerations
- Ensure the design and development of a product meets the needs of the target user
- Used as a guide the entire design process by providing clear directions and serves as a reference to the designers.

- Used during:
    - Ideation – help select idea
    - Development – help make suitable design decisions
    - Evaluation – check if prototype meets design specifications
- Include:
    - Aesthetics
    - Comfort
    - Size
    - Safety
    - Functions
    - Material

D&T – Design

Research

Primary, Secondary and Sources

- Important to make sure that all information is up-to-date and applicable to target user.
- **Primary data**
    - Data collected by you
    - Information coming directly from experiments/contributions from other people through discussions and surveys
    - Sources
        - Questionnaire / Survey
        - Interview
        - Observations
        - Product analysis
- Secondary data
    - Data collected by someone else
    - Information extracted from existing publications / databases
    - Sources
        - Internet
        - Articles in magazines / newspapers / journals
        - Videos / TV programmes
        - Statistical information from marketing companies

Observational Research

- Involves the user looking at an event or activity with an intent or purpose with the aim of collecting information about the problem or user.
- Process
    1. Photo-taking / Sketching / Video-recording / Note-taking etc.
    2. Write down observations
    3. Elaborate problems through writing and sketching
    4. Consequence of user's habits / actions

D&T – Design

Product Analysis

- **ACCESSFM**

Aesthetics • Describe how it looks? Does the design appeal to the users? Why? Is it the shape/ colour/ appearance?	**Size** • (L x B x H)mm. Is it too big or small for the user? Is it going to be portable?
Cost • Is it expensive/ cheap? Will people buy it due to its cost?	**Safety** • Is it safe to use? Any safety or health concerns when using the products?
Customer • Who are the target users? Why? Does it address the users' needs? Is it comfortable for them to use? How can you tell?	**Function** • What is the purpose of the part? What is it used for? Is it an advantages or disadvantages to have?
Environment • Will the design or materials used impact the environment?	**Material and Manufacture** • Plastic, Metal or Wood? Why did the designer use this material for this part of the product? What are the properties of the material?

- 4-step approach
  - **Identify** and **Name** the parts
  - **Analyse** the parts
  - **Sketch** to show how the product works and to trigger and develop new ideas/ solutions
  - **Identify** the important **feature** and **analysis** and **sum up what you have learnt at the end of the analysis** (Which may be used as part of your design consideration)
- **Analysing** parts

Function • What is the purpose of this part? What is it used for?	**Colour** • Are the colours used bright or dull? Are there reasons for it?
Safety/ Comfort • Is it comfortable and safe to use? How can you tell? What are the safety features?	**Texture** • How does the surface feel like? Why is that so? Is there a purpose?
Shape • Why is it shaped this way? To allow users to hold it easily or store items in it easily?	**Advantages** • What are the positive features of this design and why?
Appearance • Does the design appeal to the users? Why? Is it the shape/ colour/ appearance?	**Disadvantages** • What are the negative features of this design and why?
Material • Plastic, Metal or Wood? Why did the designer use this material for this part of the product? What are the properties of the material?	**Users** • Who are the target users? Why?

D&T – Design

Survey

- Tools to gather information about individuals (users)
    - Information (needs, habits, etc)
    - Collect opinions, preferences from the individuals (users), etc
- Can be created before or after the product is made.
- Important to craft out the questions properly so that responses can be used in a useful way.

- Types of Questions
    - Closed questions
        - Single, factual response. E.g. What colour are your eyes?
    - Structured Questions
        - Break long questions into smaller parts. E.g. Do you own a mobile phone? If your answer to the question was 'yes' then please answer question 1a – 1d. Otherwise, proceed to Q2.
    - Open ended questions
        - Express opinions freely without being restricted to pre-defined responses. E.g. What do you like or dislike about this design?
    - Rating questions
        - Indicate an attitude or opinion based on a ranking scale
        - E.g. How would you rate this product?
          ___Excellent ___Good ___Average ___Poor

- Present data
    - Pie chart
    - Bar graph
    - Summary table
    - Mind maps

D&T – Design

Social & Sustainable Design

- Socially responsible design
  - Attitude that emphasizes needs and experiences of people over concerns of form / aesthetics → may come out of humanist perspectives that emphasizes cultural value and meaning of places
- Ensure that designs do not cause harm to environment or negatively impact society
  - Develop environmentally friendly product
  - Bring positive benefits to society
- Social Design
  - Put people's needs at heart of designing process > making a product look aesthetically pleasing
    - E.g. Inclusive? Adjustable to suit different body sizes?
- Environmental and Sustainable Design
  - Sustainability → preserve Earth's natural resources
  - Finite resources (cannot be replaced)
    - Plastics → crude oil
    - Metals → extracted from ores
  - Non-finite resources
    - Wood → originates from trees which can be replaced
  - Renewable resources → replaced at the same rate they are used

Methods for sustainability in Design

- 6Rs

Reduce	Rethink
Reuse	Refuse
Recycle	Repair

D&T – Design

Ideation Techniques

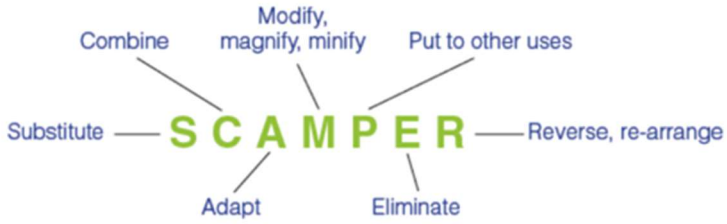
Brainstorming

- Generate a lot of ideas in a short period of time

Shape borrowing

- Drawing inspiration from surroundings, nature, things encountered
- Shape/form can inspire design of totally different problem / portray emotions
- Aesthetics:
    - Look and feel
    - Just as important as function

SCAMPER



Attribute Listing

- Generate ideas for a new product based on a set of attributes / features.
- Method:
    - Identify product.
    - List attributes (e.g. parts, properties, qualities, design elements) of product.
    - Choose interesting / important attributes.
    - Think of ways to change each attribute.
    - Combine new ideas to create new product.

D&T – Design

Detailed Development

CAD Models

- Computer-aided design → 3D drawing program used for drawing
- Provides realistic view
- Can be rendered with different materials and colours
- Can link with a laser-cutting machine → cut out parts / scale model of design

Ergonomics

- The study of the design of products so that people can interact with them in a comfortable, safe and efficient way.
- E.g.

Anthropometric

- Concerned with size and proportions of human body
- Includes:
  - height
  - weight
  - hand size
  - maximum reach
  - angles of limbs in various positions etc.

D&T – Design

Interface Dimension

- Finding of interface from product
    - E.g. Product: Tealight candle holder
      Interface: Tealight
- Derive product dimension from interface dimension
- Use together with anthropometric data
    1. Find out the interface dimensions (interface) that is going to be placed in the product
    2. Find out the finger thickness dimensions (anthropometric) that is going to be in contact inside the tray compartment
    3. Overall dimensions = interface dimensions (with) anthropometric data

User Feedback

- Feedback from the target user
- Helps designers to adjust or improvements to the design
- Determines if the product will be appealing to user
- Ensure feedback is recorded.

D&T – Design

Using mock-ups to design

Modelling

- Ensure design looks right from different angles – proportion, balance
- Design works up to your expectations (as per design specifications)
- Check if ergonomics of a design are acceptable
- Evaluate the safety of the design
- Check if the parts fitted together
- Can use it for **user's feedback**

Sketch Models

- Quickly constructed → visualise idea in 3D dimensions
- Basic impression of idea
- Useful in communicating design to other people
- Paper, cardboard, foam board
- Quick construction methods.
  e.g. hot melt glue (hot glue gun), tape etc.
  - E.g. Students made a sketch model of water feature
    Aim: used to work out the positions and sizes of the three bowls.
    Bowls were made as conical forms instead of bowl shape → quick and easier to use conical shape to present them.

Block Models

- Work out shape and dimensions of design
- Allow designers to test with interface and user
- Able to test main functions and ergonomics

Development / Experimental Models

- When design ideas start taking shape, there is a need to work out on finer details
- Use to check if design works as expected

Computer Model (CAD)

- Computer-aided design → 3D drawing program used for drawing
- Provides realistic view
- Can be rendered with different materials and colours
- Can link with a laser-cutting machine (3D Printing) → cut out parts / scale model of design

D&T – Design

3D Printed Models

- 3D Printer creates object by 'printing' in very thin layers, one at a time
- Material extruded from heated nozzle onto build plate
- Distance between each layer → layer height

Model materials

- Cardboard
  - Recycled and used to make models by cutting with scissors or pen knife → joining different parts together with masking tape or clear tape
  - Benefits
    - Durable → strong, does not tear easily
    - Made up of wood fibers → recyclable and sustainable
    - Can be cut and folded at different angles to make many different sized and shaped box designs
  - Drawbacks
    - Difficult to bend into irregular shapes
- Paper
  - Cut paper with scissors or pen knife → joining different parts together with masking tape or clear tape
  - Benefits
    - Light and thinner than cardboard
    - Can be rolled into circular shape
    - Flexible and can form into irregular shapes easily and quickly
  - Drawbacks
    - Not able to support heavy weight (i.e. not ideal to hold interface)
    - Tear easily unless multiple layers used
- Foam
  - Thicker
  - Cut with penknife or scroll saw machine → sandpaper and join all different parts together with hot melt glue
  - Can be used as many food / electrical appliance packaging.
    E.g. Takeaway food packaging, Electrical appliance internal packaging (absorbs shock)
  - Benefits
    - Light and very easy to cut
    - Easily moulded into different forms
  - Drawbacks
    - Cannot be spray painted as will eat into Styrofoam
    - Time-consuming to form into irregular shapes
    - Mask worn over mouth and nose to prevent particles from entering lungs

D&T – Design

- Objects
    - E.g. Satay sticks, ice-cream sticks, woods, metals, plastic, recycled parts from spoilt products

Model testing and documentation

- Take as many picture as you can of your model (different angles, different parts/ zoom in, zoom out)
- Must be PURPOSEFUL
    - Comment how you test for ergonomics and anthropometry
      join the different parts of the model
      its function – check with its interface
      its stability, mechanism, shapes, safety
- Must lead TO INSIGHTFUL DECISION MAKING
    - Evaluate the testing
- MUST show the DEVELOPMENT OF DESIGN IDEAS
    - Modify necessary changes and update new dimensions

D&T – Design

Evaluation

Evaluating Existing Products

- Important research
- Compare against each other / take them apart
- Analyse in terms of: →

Functions	Ergonomics
Materials	Aesthetics
Manufacture	Cost etc.

Evaluating Design Solutions

- Good evaluation reveal:
    - How well solution meets needs identified in design brief
    - How design can be improved / made
    - How well solution satisfies design specifications
- E.g. Evaluate against Design Specifications

Evaluate by Surveys / Interviews

- Finding out reactions of intended users of product
    - Reactions: whether they like it / buy or use it
- Find out suggestions to improve solution
- Possible evaluation questions:

To what extent does the product satisfy the needs identified in the design brief?	Is the product socially acceptable?
Is the product reliable?	Does the product fit in with its environment?
Is the product safe to use?	Is it visually appealing?
Will the product cause any harm to the environment?	

- Evaluation forms
    - Gather feedback from others about an idea / product
    - Questions phrased in different ways depending on information needed
    - Information recorded in a table
- Presenting findings
    - Explain results and conclusions of surveys / interviews

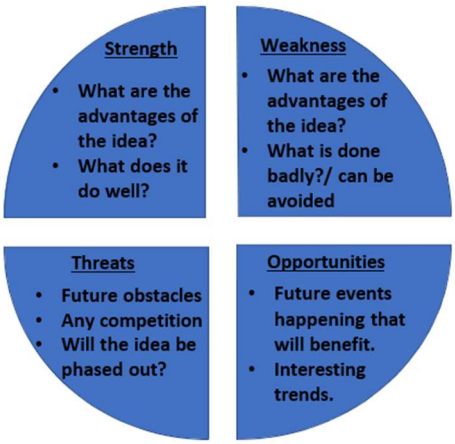
D&T – Design

PMI Techniques

- **P**lus
- **M**inus
- **I**nteresting

- Used to evaluate ideas
- Steps
    1. Create a row of **Plus** heading, write down all the **positive** points of the ideas.
    2. Create a row of **Minus** heading, write down all the **negative** points.
    3. Create a row of **Interesting** heading, write down any **implications** (+ve/-ve) of the ideas.
    4. Give a score for all the points of range -10 to 10.
    5. Tabulate and choose the one with the highest score.

SWOT Analysis



- **S**trength
- **W**eakness
- **O**pportunity
- **T**hreats

- Decision-making method according to:
    - Strength / weaknesses of an idea
    - Opportunities / threats that result from it
- Evaluate ideas and problems
- Steps:
    1. Create a table of selected Ideas for evaluation
    2. Perform SWOT Analysis for each Idea
    3. Find out which is the most ideal solutions to work on.

Refer to the table below for all the questions for SWOT.

Strengths: • What are the advantages of the idea? • What does it do well?	**Weaknesses:** • What could be improved? • What is done badly / should be avoided?
Threats: • What obstacles do you face? • What are others doing that might affect your idea? • Are there future changes that could threaten the success of the idea?	**Opportunities:** • Where are the good opportunities facing you? • Are there any interesting trends you are aware of?