Teacher Workbook AS2.2 and AS2.8 Digital Technologies

Note on how to use the teacher workbook.
The workbook has been made to help clarify aspects of the two Achievement standards AS2.2 Design and AS2.8 Develop. Hopefully it will provide some context for the assessment and a logical progression for the unit of work

When you see the symbol opposite, it refers to a possible student task that aligns with the Achievement standard criteria.

Contents Page

Teacher Workbook

Apply conventions to develop a design for a digital technologies outcome AS2.2 | 91891v1

Stage 1 - Purpose and end-users

Students need to describe the purpose and end-users of their outcome

1 Purpose & end-users | 2 Design tools & conventions | 3 Relevant Implications | 4 Generating & modelling | 5 Select & Justify

Who are the end-users

All real-world digital technology outcomes have an end-user in mind.

1. Users that will administer the outcome. Fix it if it breaks, maintain it, update it, replace the batteries
2. Users that will use it. Read and interpret the data or information and use this information to make decisions.

What it will do?

When exploring the purpose of your project, it's good to list out what your outcome will do. Do this by identifying input, process and output and power requirements.

3. What **inputs** will your outcome have?
   Inputs allow you to sense or monitoring environmental conditions such as light levels, temperature, soil moisture and water reservoir levels. Sensing also refers to monitoring switches for change of state.
4. What **outputs** will your outcome have?
   Outputs refer to the use of valves, fans, motors, servos, LED's, Radio transmitters etc and also the controls on a user interface that provides the user with information or alerts on the state of the electronic system.
5. What **processes** will your outcome do?
   The decisions that need to be made or data that needs to be stored.
6. Components have specific **power** requirements, what will your outcome require?

What will look like?

When exploring the physical look and feel of your project, it's good to list ...

7. What size, shape, colour is your outcome? What box or enclosure will your outcome have to house all components? What mechanical or moving parts are required?
8. Whether your outcome will be breadboard, Soldered board or Printed Circuit board? How you will make your outcome robust?
9. How users will interact with it?
   How will users operate, control or just interact with your outcome? How will users know your outcome is working? What display devices (LED, LCD, Module Phone, Webpage) will your outcome use to display data on?

Student Task: Read the section Purpose and End users. List ideas under the following headings.

1. Who are the end users

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2. What will it do

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3. What will it look like

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Student Task: Describe the purpose of the outcome and the requirements of the end users.

Stage 2 - Design tools and conventions

Students need to investigate design tools and conventions

1 Purpose & end-users | **2 Design tools & conventions** | 3 Relevant Implications | 4 Generating & modelling | 5 Select & Justify

Block Diagrams

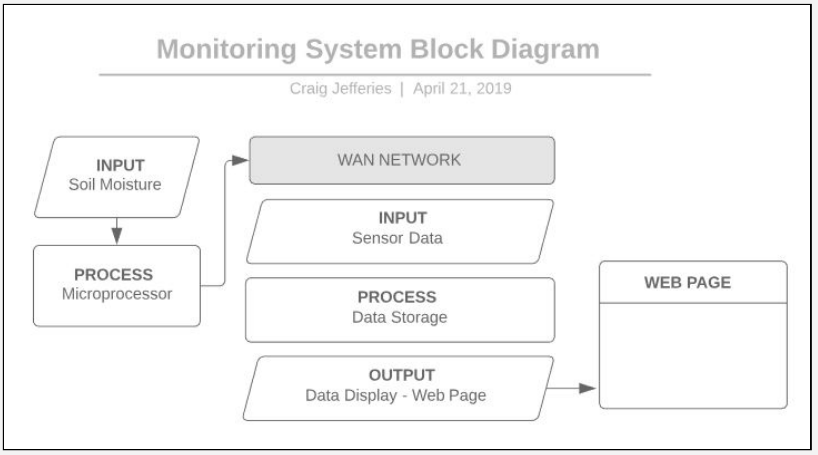
System Block Diagrams

Block diagrams are used to help decompose a system into components. They are a method of explaining complex systems in a simple manner.

Conventions for block diagrams

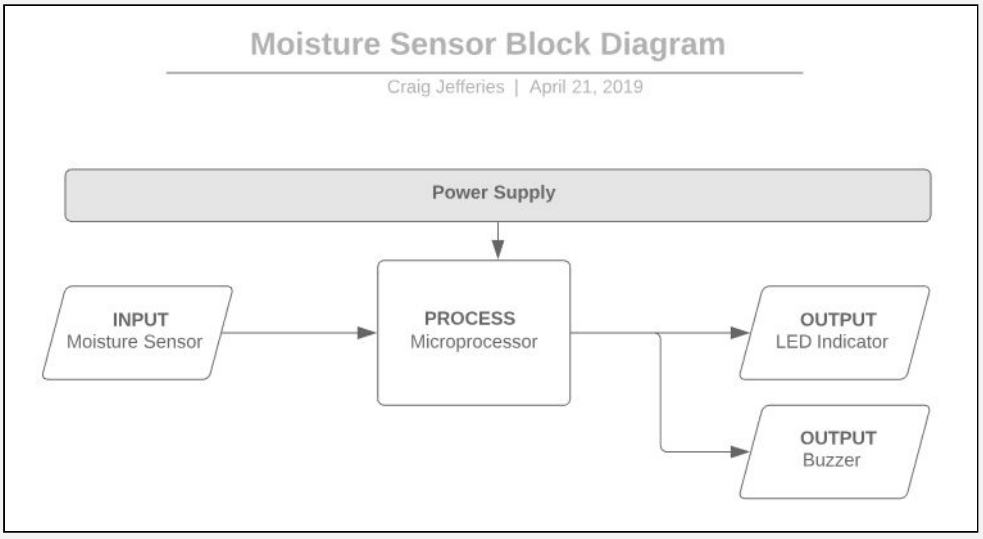
- They are made up from labelled blocks which are joined by arrows. The arrows indicate the direction of flow.
- Inputs and Outputs are identified and labelled with s simple description
- Use a Title Block that states the name of the circuit, your name and the date created

System Block Diagram for Monitoring System created with lucidchart.com



Electronic Block Diagrams

In electronics, block diagrams are a visual way of thinking about the inputs (sensors, buttons), processes (logic and control structures), and outputs (LED, Buzzer, Motors, Servo's).



Block Diagram for Moisture Sensor created with lucidchart.com

Inputs: Circuits convert physical world inputs (like Touch, Light, Temperature, Moisture Level, Water Level, Movement) to electrical voltage signals which are processed by a microcontroller. These physical world inputs are sensed using electronic components.

- The thermistor will sense temperature,
- Light Dependent Resistor (LDR) will sense light levels,
- Conductivity Probes sense moisture,
- Tilt or push switch will sense movement

Processes: The electrical signals sent to a microcontroller to be processed. A Microprocessor reads input, makes decisions and then turns output pins on or off. We have a number of different microprocessors available this year to use

- PICAXE 08m2 and 14m2: An 8-14 Pin microprocessor
- Atmel ATtiny85: An 8 Pin microprocessor
- Arduino Nano: 12 Digital pins and 7 analogue pins on a development board

Outputs: Outputs include devices such as Lights LEDs, Motors, switches, speakers or buzzers to make sounds. Even sending data via Infrared or Radio Transmission (these are outputs)

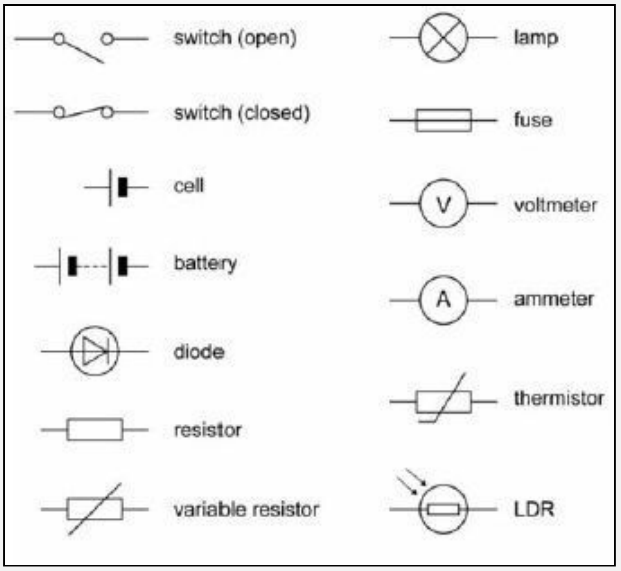
Circuit Schematics

A schematic is a visual representation of a circuit. As such, its purpose is to communicate a circuit to someone else. We use conventions when drawing circuit schematics to make a design easy to read, easy to understand what electronic components are needed and how components connect to one another.

Circuit Schematic Conventions

Some conventions to follow when sketching circuit schematics

- Use a Title Block that states the name of the circuit, your name and the date created
- Make sure you get the circuit symbols correct.
- Clearly show where wires connect, or where wires cross over but do not connect
- Make sure every component has a unique designator
    - Label resistors R1 330, R2 4k7, R3 10k, R4 10K NTC, R5 10k LDR
    - Label diodes D1 5mm LED,
    - Label Batteries BAT1 4.5v
- Neatness and presentation count, make sure the schematic is easy to read



Interface Wireframes

The Electronic User Interface

Electronic user interfaces provide the user with a way to understand the state of the system, and also to provide a means to control or adjust aspects of the system.

Mockups of the electronic user interface to focus on

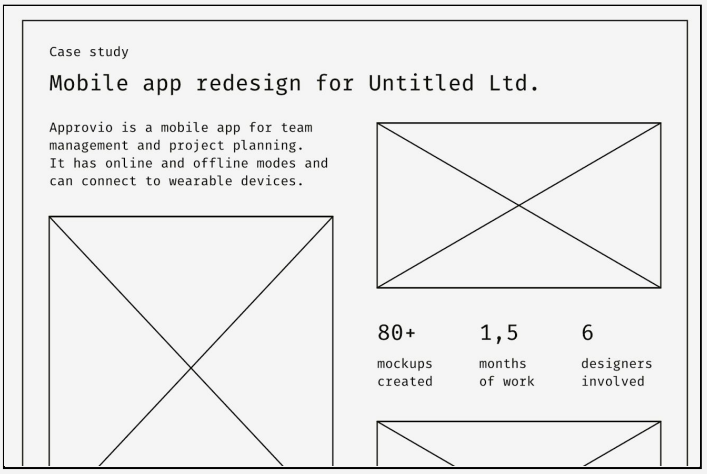
- The size and position of buttons, switches,
- The position and colour or LED's for displaying status on the system

Website wireframes

Outcomes such as mobile apps and websites have specific interfaces that the user interacts with. From small mobile phones to large screen monitors to tablets.

User interface mockups are used to help determine the content inside the screen.

- Headings
- Paragraph Text
- Images, pictures or Graphs / Charts
- Buttons and navigation



Conventions for wireframes and user interface mockups

There a number of design conventions used when designing website wireframes or user interfaces

- Visual Hierarchy: Visual hierarchy refers to the arrangement or presentation of elements in a way that implies importance
- Usability Heuristics: A heuristic evaluation is a way to test whether a website is user friendly. In other words, it tests the site's usability

Student Task: Research design conventions for your chosen design.

What did you research, what did you find out?

_____

_____

_____

_____

Student Task: For each of the design tools listed below, describe them and list the conventions

1. **System Block Diagram**

   Description

   _____

   _____

   Conventions used

   _____

   _____

2. **Circuit Schematics**

   Description

   _____

   _____

   Conventions used

   _____

   _____

3. **Interface Wireframes**

   Description

   _____

   _____

   Conventions used

   _____

   _____

Stage 3 - Relevant Implications

Students need to explain relevant implications

1	2	3	4	5
Purpose & end-users	Design tools & conventions	**Relevant Implications**	Generating & modelling	Select & Justify

Read through the relevant implications below then answer the questions that follow

Social	Health and safety	Legal	Ethical
Is the electronic system suitable for the intended user (understandable and usable), What does the client want, and does your electronic system deliver?	How can we maintain safety within the development and ongoing operation?	Much of the code can be reused from internet sources! Does it comply with Copyright laws? ,Did you get permission to place electronic system in situ, Is the data your electronic system captures private or sensitive?	Should we be doing this? Should we be using cheap Chinese Arduino clone hardware?

Intellectual property	Privacy	Accessibility	Usability
Who owns the ideas, the images, the code? Should you protect your ideas via Creative Commons or Copyright?	Are there any privacy issues of the data you are collecting?	Should the outcome be easily accessible to everyone?	Is it easy to operate? Can the user use the electronic system easily/intuitively, Does your electronic system show current status of system Should you include instructions or labels on the enclosure? Is it easy to navigate or control

Functionality	Aesthetics	Maintainability	End-user considerations
Is it important that it works as intended? Correctly sensing input, correctly processing data providing accurate and true output.	Making something beautiful, giving it a pleasing appearance, Elegant- a solution achieved using well-chosen components, concise coding and a simple, yet clever, design	How will it be maintained? Can you keep it up to date? How will you make it easy to fix or change batteries?	What specific needs do the end-users have? How will the user know its working? Can the user control it, will they understand the output?

Software Standards	Reliability	Robustness	
What are software codes of practice and how can your outcome adhere to these? Variable names, code comments program naming conventions,	What would happen if the system was unreliable? How could we improve reliability? What testing needs to happen to make sure it's reliable	Will your system be used outside? Does it need to be waterproof? Does it need to be stable, portable? How will this be achieved?	

Student Task: Rank the implications. *There are at least 15 implications that may or may not relate to your outcomes design and development. Rank the implications from most (1) to least (15) important*

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____

Student Task: Explain how the most relevant implications (top 3) applies to your project, and how you intend to address these within development

Relevant implications 1: Explain how the implication applies to the outcome. Explain what the outcome needs to do or to include to meet the implication.

Relevant implications 2: Explain how the implication applies to the outcome. Explain what the outcome needs to do or to include to meet the implication

Relevant implications 3: Explain how the implication applies to the outcome. Explain what the outcome needs to do or to include to meet the implication

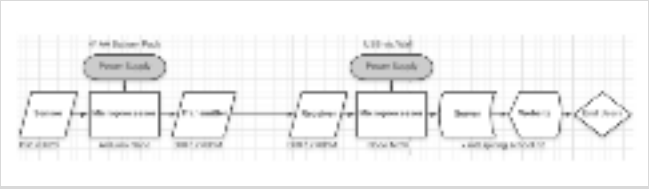
Stage 4 - Generating and modelling

Student need to use design tools and conventions to generate a range of design ideas

Generate ideas

Generating a range of design ideas for

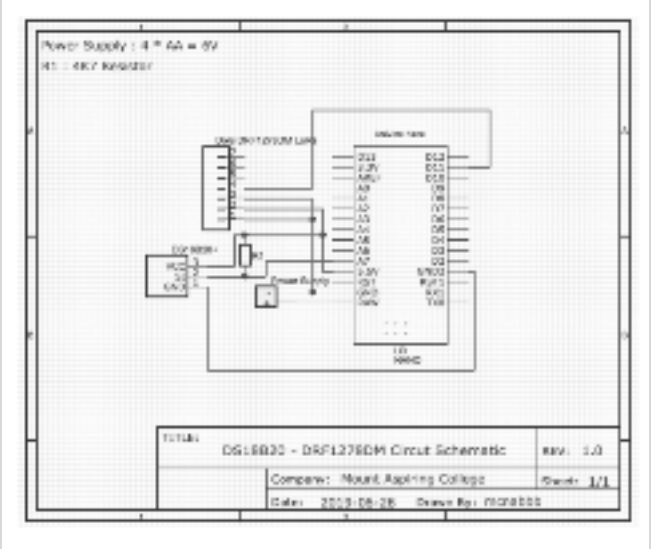
System Block Diagram
Sketch a system block diagram for your outcome. Apply design conventions



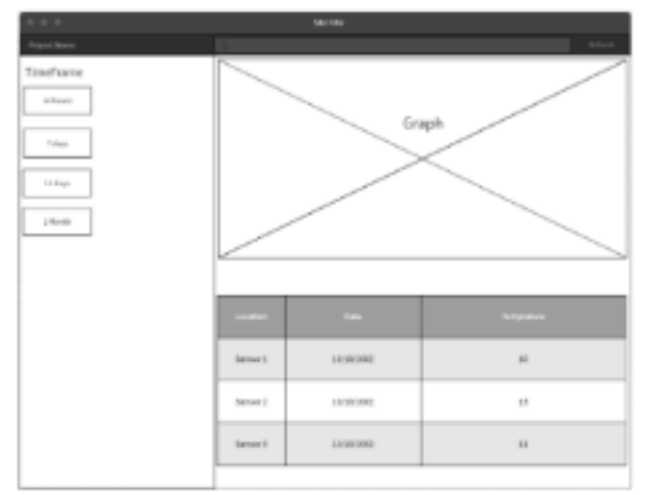
Database table and fields
Sketch your database table and field ideas for your outcome. Apply design conventions

```
{
    "id": "36",
    "location": "Ky",
    "quantity": "c",
    "data": "2.25",
    "created_at": "2019-06-24 12:00:55"
},
{
```

Electronic Circuit Schematic
Generate a circuit schematic for your outcome. Apply design conventions



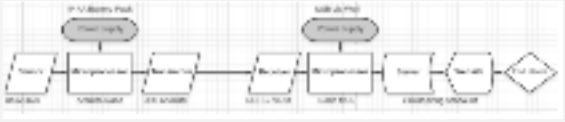
Webpage wireframes
Sketch website wireframes for your outcome. Apply design conventions



Model your ideas

Model a range of design ideas. Modelling means to test, to check or to trial in order to gain information on your design. Let's look at a few modelling examples

Modelling the System Block diagram

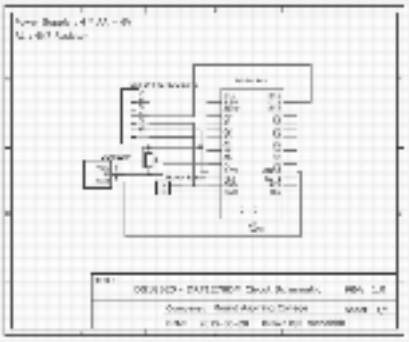


Modelling that could be done:

1. Ask your teacher if you have got all the inputs, outputs and processes right!
2. Check that you have used correct design conventions (shapes and symbols)

Does the design address relevant implications?

Modelling the Circuit Schematic



Modelling that could be done

1. Ask your teacher whether you have the circuit diagram drawn correctly? Have you used correct circuit symbols, and circuit designators and labels?
2. Construct a breadboard version of the circuit and program it, then test to make sure it works as expected.

Does the design address relevant implications?

Modelling the website wireframe

Modelling that could be done

1. Survey users, asking them
    a. Do you understand what the page is about?
    b. Can you read and interpret the data that is being displayed?
    c. Does the layout work on multiple devices (laptop, phone etc)
    d. Does the typography, colours fit with the theme of the site

Does the design address relevant implications?

Student Task: Generate and model a range of design ideas.

Stage 5 - Select and Justify

Students need to select and justify a design idea

1 Purpose & end-users | 2 Design tools & conventions | 3 Relevant Implications | 4 Generating & modelling | **5 Select & Justify**

Selecting a design for the purpose of the outcome and explain the appropriateness of the design

- explaining how the chosen design uses appropriate conventions and showing within your designs that you have addressed relevant implications and end-user considerations
- justifying how the chosen design addresses implications, end-user considerations, and uses appropriate conventions.

Student Task: List the design conventions used, and the relevant implications you chose

Design Tools and Design Conventions used

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Relevant Implications you chose

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Student Task: Justify how the chosen design addresses implications, end-user considerations, and uses appropriate conventions.

Use advanced processes to develop an outcome AS2.8 91897v1

Advanced processes

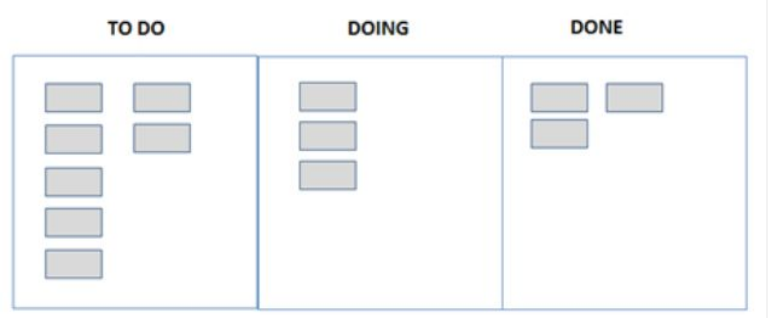
The advanced process are the steps taken to develop a digital technology outcome. Depending on the project you have to complete, there are a range of process that may be used

- Electronic circuit construction
- Programming
- Enclosure Development
- Webpage Development
- Server-Side PHP and MySQL

Stage 1 - Project Management

1 Project Management | 2 Decomposition | 3 Relevant Implications | 4 Development - Trialling & Testing | 5 Evaluation, Discussion

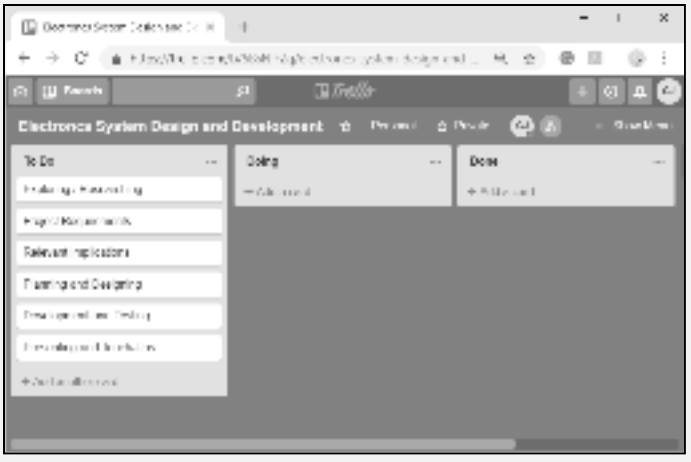
Managing Tasks with www.trello.com



A Kanban board
A kanban board is a visual method of organising tasks within a project. It allocates tasks into three categories.

- To-do
- Doing
- Done

Keep it together with trello.com
Trello.com is a web application that allows for the allocation of a task in the style of a Kanban board. It enables you to place due dates on tasks, break tasks into list or items and most importantly give you the ability to move tasks from to-do -> doing -> done columns.



Student Task: Sign up to www.trello.com and create a "board". Share this with your teacher

Stage 2 - Decomposition

1 Project Management | **2 Decomposition** | 3 Relevant Implications | 4 Development & Trialling | 4 Development - Trialling & Testing | 5 Evaluation, Discussion

Project management is all about how we can create software despite this enormous size and complexity and hopefully get a working outcome in the end. We will rely on a technique called decomposition. Decomposition is the process of breaking an electronic system, or any digital outcome, into smaller components.

Example Decomposition of Temperature sensor

Decomposition into smaller components for Temp Sensor.

1. To-do Trial components and select components for use in the development of temperature sensing, radio transmission.
2. To-do Construct Temperature Sensor electronic interface. Write Arduino C++ code to read the temperature value
3. To-do Trial temp and radio transmission on long range line of sight. Record results

Depending on the tasks allocated student may also need to decompose the HTML web page development and the PHP - MySQL connection, queries and echo-ing of data to an HTML page

Decomposition or your task

Student Task: Decompose your development into smaller components. Set up a Trello.com board with your "to-do list"

Place in a screenshot of your trello board

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Stage 3 - Relevant implications

1 Project Management | 2 Decomposition | 3 Relevant Implications | 4 Development - Trialling & Testing | 5 Evaluation, Discussion

Read through the relevant implications below then answer the questions that follow

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Software Standards	Reliability	Robustness	
What are software codes of practice and how can your outcome adhere to these? Variable names, code comments program naming conventions,	What would happen if the system was unreliable? How could we improve reliability? What testing needs to happen to make sure it's reliable	Will your system be used outside? Does it need to be waterproof? Does it need to be stable, portable? How will this be achieved?	

Rank the implications

Student Task: There are at least 15 implications that may or may not relate to your outcomes design and development. Rank the implications from most (1) to least (15) important

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____

Explain how you will address implications

Student Task: Explain how the most relevant implications (top 3) applies to your project, and how you intend to address these within development

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Relevant implications 3: Explain how the implication applies to the outcome. Explain what the outcome needs to do or to include to meet the implication

Stage 4 - Development Trialling & Testing

Developing your outcome means to make, build, develop, construct, code, debug, trial and test ... but in an organised manner

Where to start development?

As a teacher or student, there are two ways to approach skill development in this "trialing stage" prior to the development of the outcome. Complete a series of small tasks that embed the skills and knowledge needed OR use a "learn as we go approach". It is preferable to have a go at the small tasks as this allows for greater independence later on when they pull it all together. One hour for each task

- Task 1: Measure temperature using a DS18B20 on a microprocessor
- Task 2: Send data via radio modules across the classroom
- Task 3: Monitor current draw from an embedded electronic device
- Task 4: Build a basic enclosure for the electronic device.
- Task 5: build an HTML page with nav, banner and main body
- Task 6: Create a PHP page that connects to a database, and selects all temperature data, isplaying this using an echo statement onto an HTML page
- Task 7: Use Chart.js to create a static chart embedded within a webpage
- Task 8: Modify the chart.js dataset so that it displays temperature data from the database.

You need to follow a Project management process.

Keep to the plan, Update your plan. Update your Trello.com board, moving tasks from todo to doing to done.

You need to Trial / Test components and make improvements

Trialling applies to electronic components, hardware interfaces and software code

Student Task: Developing and testing the input interfaces of your outcome

What Input interface components - Trial different Temperature Sensors such as 100k NTC or Ds18B20 or LM35. Test your inputs, are they able to cope with long periods of inactivity, low battery, and extreme (boundary) input conditions.

Photo of Input interface (temp sensor) (take a photo and place here)	Sample C++ code for input interface (temp sensor) (show file name) (Take a screenshot and place here)

Complete the testing table for your inputs

Testing Table		
Test	What happened?	Was it expected? What To-do?
Reading in Temperature value	Screenshot of Serial Terminal showing results	
Checking that temperature values are correct using an actual thermometer		
Boundary input conditions		

Improvements or Modifications to Hardware or Software Code

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UPDATE YOUR TRELLO.COM BOARD

Student Task: Developing and testing the output interfaces of your outcome

What Output interface components - Radio Transmission. Trial the Dorji ASK or the HC-12 or the Dorji DRF1278DM. Test your outputs, are they able to cope with long distance, obstacles. Other outputs such as LED + Series resistor to show operation, what current and voltage requirements are needed

Photo of Output interface (Radio) (take a photo and place here)	Sample C++ code for output interface (Radio) (Show file name) (Take a screenshot and place here)

Complete the testing table for your outputs

Testing Table		
Test	What happened?	Was it expected? What To-do?
In Class (short range)		
Outside (long range)		
LED + Series resistor	Measure voltage and current	

Improvements or Modifications to Hardware or Software Code

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UPDATE YOUR TRELLO.COM BOARD

Student Task: Developing and testing Electronic Enclosure

What Enclosure materials - Veroboard or Kiwipatch board, or PCB. Boxes pre made or handmade. Maybe a PVC pipe?

Photo of Enclosure (take a photo and place here)	Photo of Enclosure with components installed (take a photo and place here)
Testing of enclosure in its intended location (Take a photograph of enclosure and components in actual locations)	

Improvements or Modifications

_____

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UPDATE YOUR TRELLO.COM BOARD

Student Task: Developing and testing HTML / CSS web page

What software tools will you use for development. Notepad++, Brackets.io, ATOM? Develop a framework or layout page for your web page. Including navigation, banner, columns and footer..If using Charting libraries - Trial Chart.js and Plotly.js libraries

Screenshot of HTML page	Sample HTML code

Complete the testing table for your outputs

Testing Table		
Test	What happened?	Was it expected? What To-do?
Browser testing (Safari, Edge, Chrome)		
Feedback from stakeholders		

Improvements or Modifications to HTML CSS and layout

_____

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_____

UPDATE YOUR TRELLO.COM BOARD

Student Task: Developing and testing PHP code and MySQL database queries

Develop sample PHP files do three things (1) connect, (2) query and (3) echo data to an HTML page.

Screenshot of PHP code	Sample HTML output from echo statement

Complete the testing table for your outputs

Testing Table		
Test	What happened?	Was it expected? What To-do?
Run a basic query SELECT * from $table	You should expect all data to echo to page	
Run a more advanced query SELECT field from $table WHERE created_at = “”	You should expect specific data to echo to page	

Improvements or Modifications

_____

_____

_____

UPDATE YOUR TRELLO.COM BOARD

Make improvements and refinements

Bring all the elements together. This means place the sensor in-situ for a few days, collect data and using your webpage to display the data.

- What could be improved?
- Does it meet relevant implications?

Screenshot of PHP code	Sample HTML output from echo statement

Complete the testing table for your outputs

Testing Table		
Test	What happened?	Was it expected? What To-do?

Improvements or Modifications

_____

_____

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UPDATE YOUR TRELLO.COM BOARD

Stage 5 - Evaluation, Discussion

1 Project Management | 2 Decomposition | 3 Relevant Implications | 4 Development - Trialling & Testing | 5 Evaluation, Discussion

Evaluation

Student Task: How did the information from planning, testing and trialling of components assisted in the development of a high-quality outcome

How does your outcome meet the base specifications of the project found on page 1

How does your outcome address relevant implications

How did the use of a develop - trial - test process enable refinement of your outcome

Student Checklist for AS2.8

Have you completed the following tasks in the assessment

- ❑ Signed up to www.trello.com and created a "board"
- ❑ Decomposed your project into smaller tasks
- ❑ Ranked the relevant implications
- ❑ Selected 3 implications and explained them
- ❑ Develop and Test Input interface
- ❑ Develop and Test Output interface
- ❑ Develop and Test Electronic Enclosure
- ❑ Develop HTML / CSS web page
- ❑ Develop PHP - MySQL
- ❑ Make improvements and refinements
- ❑ Evaluation, Discussion