CG1112: Embedded CELC Module Semester 2, AY 2021

Workshop 1: How to develop your Project Report into your Final Design Report

Student Notes

Report writing goals:

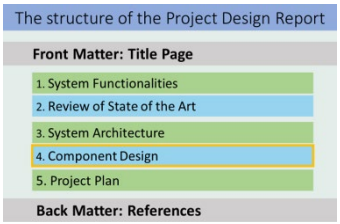
Aim to write a Final Design Report that is **clear, specific** and **easy to read**.

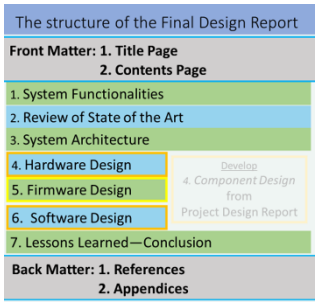
Here are some general guidelines to keep in mind:

- Follow the given format closely. Wherever possible, use headings and sub-headings that clearly indicate the focus each section in the Report.
- Organise your information. Present descriptions and explanations in a logical order.
- Write simply and precisely. Provide specific information (e.g., numerical data, dates) where possible. Avoid vague terms and unnecessary descriptors.
- Each section should begin with a brief Overview (summative statement) that introduces the focus of the section to the reader. This can be very brief (1-2 sentences). However, it must be in continuous writing.
- Be selective in your use of lists; not all explanations and descriptions can be listed coherently.
- Illustrations need explanations. Every diagram, table and photograph should be described, explained and interpreted for the reader. Include clear captions and labels.

How is the Final Report different?

The Project Report was a draft; the Final Report resembles a professional technical design report.





You will need to develop the first 4 sections and **add a reflective (technical) conclusion.**

Most significantly you will need to **expand the component design section** into 3 separate sections: hardware, firmware and software design.

Section 1: Introduction	
System Functionalities 1. Overall aims of the project. *Concise Overview* 2. Brief plan of action. *Methodology* 1. System functionalities of Alex.	→ **Introduction** →1. Problem statement → **2.** Refine plan of action → **3.** Updated system functionalities. →4. *(Optional) Illustration design—this must be referred to in the main text.*

What is a problem statement?

If you think of your project as a problem-solving mission, then your introduction will need a clear and precise problem statement to explain the need for your specific solution.

A **problem statement** defines the problem being addressed clearly and precisely. It directs the scope of the project as it provides specific details on the nature of the problem.

When you write your problem statement, consider the 5 W's:

1. **When** did the problem occur?
2. **Where** did the problem occur?
3. **What** exactly is the problem?
4. **Why** did the problem occur? /**Why** can't the problem be resolved currently?
5. **Who** caused the problem? /**Who** is affected by the problem?

How to write a problem statement:

- Describe the 5 'W's (Who, What, Where, When and Why) of the problem.
- Focus only on one problem.
- Keep it short (only 1-2 sentences).
- Do not provide a solution within the statement.

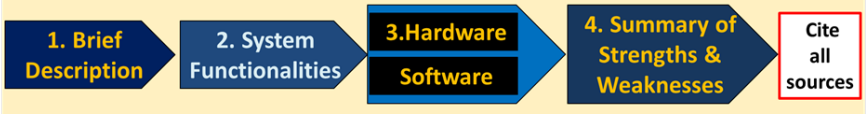
NOTE: If you find it difficult to write a coherent statement of 2 sentences, Use a third sentence. Crowding the information into one or two sentences will probably result in an unclear, incoherent, run-on sentence.

	Checklist: Problem statement	✓
1.	Is the statement 1-2 sentences long?	
2.	Did you state the time frame over which the problem has been occurring?	
3.	When you answered the WHAT question, did you **quantify** the problem? *In your case, you could provide data on the destruction of property/lives or the delays caused by the inadequacies of the current solutions.*	
4.	Does your statement focus on current problems? *i.e., Is your assessment of the problem up-to-date?*	
5.	Did you focus clearly on ONE problem? The SINGLE problem can be comprised of several interrelated problems *E.g., Because a SAR robot cannot navigate rough terrain…(a few problems occur)*	
6.	Does the statement lead into the need for your specific solution? *Without mentioning any solutions?*	

Section 2: Review of the State of the Art (Refine and develop for the Final Report)

→ 1. **Overview statement:** Briefly introduce the two tele-operating search and rescue (SAR) robotic platforms that you are going to discuss in detail in this section.
→ 2. Explain what you learned from these SAR robots that are similar in design.
→ 3. Focus on strengths and weaknesses of the 2 SAR robots.
→ 4. Say how you will emulate the strengths and try* to avoid or improve upon the weaknesses of these 2 examples.
→*Note: Your CG1112 instructors understand that you may not have the technical know-how to improve on the design of these SAR robots.

Details to include in the description of the 2 solutions **(tele-operating SAR robots)**



Section 3: System Architecture

→ 1. **Overview statement:** Write an overview sentence that introduces your diagram.
E.g., Figure 3 illustrates…

→ 2. Provide a brief and clear description of the structural design of your system.

a. Describe the diagram clearly.
b. Explain how essential components (hardware/software) communicate with each other.
c. Describe steps involved.

★*Refer consistently to the diagram in your descriptions.*

Example: The Raspberry Pi functions as…It communicates information obtained from … to

→ 3. Only include your diagram after you have provided the introductory text.

→ 4. Number and label all components clearly.

→ 5. Provide a descriptive title and place it at the bottom of the diagram.

→*Note: You may have to state what appears to be obvious to you—such as the blue boxes represent a specific component. Remember that what seems obvious to your team—the designers of the project—may not be as apparent to the reader.

Style point: Using Figures and Tables

Always precede the figure/table with a description and analysis of the illustration.
Begin with a summative sentence: Figure 3 shows…

Describe the parts and explain how they are connected.
Analyze and interpret numerical data (if featured).
Highlight significant elements in the illustration.

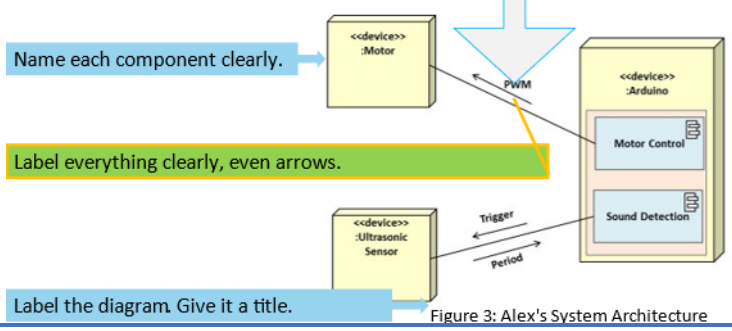


Figure 3: Alex's System Architecture

Section 3: System Architecture	***Guidelines for effective design for figures***

1. Use 4-7 graphic elements in one diagram. Feature only the important parts.

   Overloading the diagram with too many elements will make the diagram difficult to understand.

2. Use lines, arrows, columns, rows, common color to emphasize connections between graphic elements. Specify the connectionbetween graphic elements in detail

   What do elements that are blue have in common? How are they related?

3. Use a graphic element to denote a single function. One element cannot represent 2> functions in the same diagram.

   In a single diagram use one type pf arrow to represent only one of these functions:
   - – direction of force; moment of torque; direction of movement; flow of information; cause and effect.

   If you need to use arrows to denote different functions, ensure that the arrows look different.
   E.g., A single arrow for direction of movement and a double arrow for cause and effect.

4. Use standardized symbols (determined by your field).

   E.g., Rectangles represent hardware components

Section 3: System Architecture **Example**

Introduce the diagram with a summative sentence

Describe the diagram clearly

Explain how components communicate with each other

Describe the steps involved.

Highlight key features.

Figure 3 illustrates/shows ...

The yellow boxes represent ____while the blue boxes represent_____.

The motor is controlled by the ____.

The XXX program captures the rotation of YYY and communicates this information to ZZZ. The XXX motor acts as a_____ between the XXX and the _____. It converts _____ and sends it to _____. After processing this data, XXX will send a command to _____ causing the XXX to adjust _____.

See Section 4: Hardware Design: Presenting Visual Evidence (pp. 5-6) for more information on how to format images.

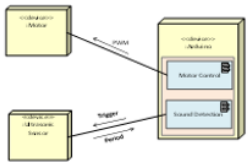


Figure 3: Alex's System Architecture

Checklist: Section 3: System Architecture		✓
1.	Have you provided an introductory statement at the beginning of your Section? E.g., *Figure 3 shows…*	
2.	Have you described the parts of the diagram? Did you indicate what colours, shapes and symbols represent? E.g., *The blue boxes represent…/ The green arrow represents…* (Remember: Subject-Verb Agreement)	
3.	Have you labelled each part of the diagram (including arrows)?	
4.	Have you explained how components communicate with each other and described how they are related? E.g., *The motor is controlled by…*	
5.	Have you described the steps involved (in the transmission of information/data)? E.g., *The XX captures the information and transmits this to the __. Then…*	
6.	Have you pointed out key or special features in your design? E.g., *The XX has a built-in sensor that has the capacity to ___*	
7.	Have you labelled the entire diagram and given it a descriptive title? E.g., *Figure 3: The System Architecture…*	
8.	Have you placed the diagram after the text?	

Develop Section 4: Component Design into 3 Sections (Hardware, Firmware, Software Design)

Design Report	Final Design Report [From the template]	
Section 4: Component Design 1. High level steps (algorithm) 2. Detailed Breakdown of Algorithm	Section 4: Hardware Design	1. A photograph of the final form of the system. Try to indicate the placement of the hardware components on the photo if possible. 2. [Optional] Non-standard hardware components used and their purpose. 3. [Optional] Additional noteworthy hardware-related stuff you did.
	Section 5: Firmware Design	1. High level algorithm on the Arduino Uno 2. Communication protocol (format of messages and responses). 3. [Optional] Additional noteworthy software-related stuff.
	Section 6: Software Design	1. High level algorithm on the Pi to handle: a. Teleoperation b. Colour detection 2. [Optional] Additional noteworthy software-related stuff.

General Guidelines for Presenting Visual Evidence

1. Orientate your reader by including at least one complete sentence that introduces your image (photograph, diagram, etc.).
2. Provide a clear label and place it below the image. E.g., Figure 1: Title that provides What/Where/When Information.*

Note: *IEEE (https://ieeeauthorcenter.ieee.org/wp-content/uploads/IEEE_Style_Manual.pdf) recommends using Fig. 1, rather than Figure 1.

In this module, we use *Figure*, rather than *Fig*. in this module because it is a choice also made by a number of credible journals and related publications (See example in page 6).

The use of Figure makes the text more readable and prevents grammatical errors. If you decide to use Fig. in your Final Design Report, do ensure that you do so throughout the Report. Also take note of the rules regarding plural/singular and articles, 'a/an/the.' See the extract from pages 12-13 of the IEEE manual on page 6.

Where style is concerned, your guiding principle should be to follow the formatting instructions given for any given task and to **maintain consistent style throughout** a document. In future modules and in your future professional life, you may be required IEEE or a specific in-house style.

3. Ensure that your label each essential part precisely and clearly.
4. Provide a simple but clear description of the image.
5. Explain how the parts relate to each other. If necessary, such as in a chart, interpret data that is visually presented.

Text Citation of Figures and Tables

All first citations of figures and tables in the article must be in numerical order. Citations to figures in text always carry the abbreviation "Fig." followed by the figure number. The abbreviation is used even when it begins a sentence.

Figures:

The general style for captions is such that each caption number should be cited with the abbreviation "Fig." and the number, followed by a period, an em space, and then the text of the caption. The first word of the caption should always be capitalized, regardless of any style that may be chosen to list caption parts (a), (b), etc., if included. If you are citing Fig. 1(a) and 1(b), the singular "Fig." is still used. In general, do not use A, An, or The at the beginning of a figure or table caption.

Example:

Fig. 1. Theoretical measured values of n.

There are several acceptable styles for listing the parts of the figure in the caption. Be consistent within each article, but otherwise use whichever style is most convenient for the figure. Regardless of which caption notation is used, the citation of (a), (b), etc., should always appear before the corresponding caption part.

Examples:

Fig. 1. Intercomplex crosstalk characteristics. (a) Electrode transmission. (b) Interelectrode crosstalk.

Fig. 2. (a) Variation of effective mode index with time. (b) Step-index change.

Fig. 3. Output resistance as a function of channel doping for 1-m-long gate. (a) InGaAs and (b) InP JFETs with pinchoff voltage as a parameter.

Fig. 4. (a) and (b) Plain and side views, respectively, of the experimental setup used to measure the effective diffraction loss which can be achieved using the feedback technique.

Fig. 1. (a) Electrode transmission. (b) Interelectrode crosstalk.

If parts of a figure after reduction will run the length of more than one page, the full descriptive part of the caption should be cited with the first part of the figure followed by the corresponding caption for the part. On the subsequent pages, the word (*Continued.*) will be placed under the carryover parts of the figure followed by a repeat of the full descriptive part of the caption and the corresponding caption for the carryover parts.

Captions for Landscape/broadside figures: The text should appear below the figures and facing outward at all times.

Examples:

Fig. 6. True and estimated spectra for a real data sequence. (a) True spectrum.

Fig. 6. (*Continued.*) True and estimated spectra for a real data sequence. (b) Estimated with the periodogram.

Tables: The general style for table captions is such that each caption number should be centered above the table with the label TABLE and the enumeration given in Roman numerals. The descriptive text of the caption should be centered directly below the table number caption

The descriptive text of the table caption does not contain a period at the end of the caption, although punctuation may be necessary within the caption itself. In general, table captions should be set as an inverted pyramid.

The style for listing the parts of a table in the caption and in text depends on whichever style is most convenient for the table. The most acceptable style is to follow the conventions for callouts of figures. Example:

TABLE I
PARAMETER VALUES

TABLE II
OPTIMAL WAVELENGTH AS A FUNCTION OF POLARIZER ANGLE. (a) WAVELENGTH FOR EXTERNAL CAVITY. (b) ESTIMATED WAVELENGTH FOR LASER DIODE

Section 4: Hardware Design — *Presenting Visual Evidence*

Arrows guide the reader's eye to specific parts of the design.

Each essential part is labelled.

An object is given to provide the reader with a sense of scale.

Photograph is carefully labelled. A descriptive title is given.

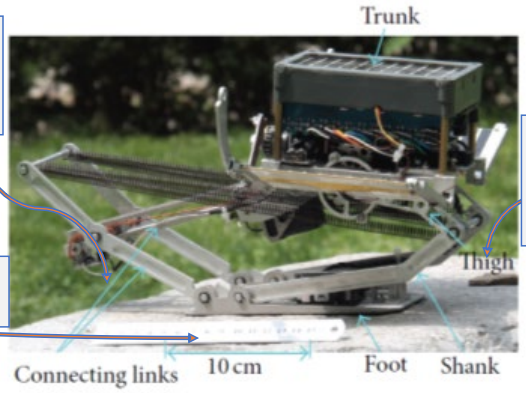


FIGURE 1: Prototype of the proposed robot [17], bioinspired by kangaroo, which is bipedal with a synchronous hopping motion along the sagittal plane of its body.

Hardware components (Optional).

Give your subsection a specific numerical label and a descriptive title.

The physical parts of the component is described in detail.

The function/movement of the component is described in sequence.

Each essential part is labelled.

Photograph is carefully labelled. A descriptive title is given.

3.4.3. The Scissors of the Manipulator

Similarly, the power switching for the scissors is also the same as the shoulder joint. Then, the reducer drives a thread screw to perform the cutting/catching work of the scissors. The structure of the scissors mechanism is shown in Figure 18a. The thread screw has two helix sections: the former is right-handed, and the other is left-handed. When the thread screw is turned to a clockwise direction, the two nuts will be close to each other, and the blades of the scissors will cut or catch a target. The power is transmitted to the reducer of the scissors from transport shaft by a pair of bevel gears (as can be seen in the left side of Figure 18b). The process of cutting out cables and steel roll bars is shown in Figure 19.

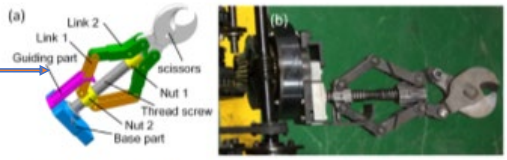


Figure 18. (a) shows the structure of the scissors of the manipulator; (b) shows the scissors' prototype.

Hardware components (Optional). *Cont.*

Labelling the sequence **(a-d)** allows readers to easily follow the progressive movement of the component.

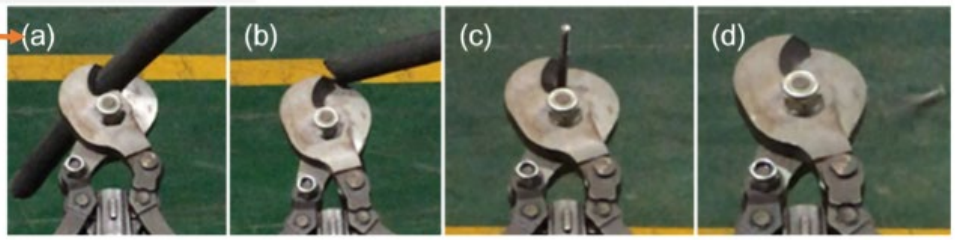


Figure 19. The cutting performance of the wrist joint assembly unit; (**a**,**b**) show scissors cutting cable; (**c**,**d**) shows cutting steel roll bar.

Photograph is carefully labelled and described.
The descriptive title is detailed enough to ensure that no further explanation or description is necessary.

[1]L. Bai, W. Ge, X. Chen, Q. Tang, and R. Xiang, "Landing Impact Analysis of a Bioinspired Intermittent Hopping Robot with Consideration of Friction," *Mathematical Problems in Engineering*, vol. 2015, p. 374290, Jul. 2015, doi: 10.1155/2015/374290.

Section 5-6: Firmware and Software — *Overview sentence*

At the beginning of each section: Provide a simple overview/summative sentence to orientate the reader

Summative statement of your firmware design.

The Arduino XXX transmits ___ and ___, thus enabling ___. This section will provide detailed descriptions of the different functions within _____ .

Statement of purpose: Explain what the following sections will provide.

Section 5-6: Firmware and Software — *Using Numbered Lists*

Signal phrases can be detailed and descriptive. Such detail will help the reader understand the list.

According to the three possible cases, the impact process can be classified into three types—unidirectional sliding impact (USI), viscous impact (VI), and reverse sliding impact (RSI)—which are characterized by the following [25, 26].

(1) USI: $\dot{\mathbf{r}}_\tau$ remains unchanged throughout the impact process.

(2) VI: in impact process, $\dot{\mathbf{r}}_\tau$ decreases gradually to zero at a certain moment t_L and then remains zero.

(3) RSI: in impact process, $\dot{\mathbf{r}}_\tau$ decreases gradually to zero at a certain moment t_L and then reverse sliding occurs.

As items in the list are complete sentences, each sentence begins with a capital letter and ends with a full stop.

Number each item.

Indent text so that the numbers are set apart from the text..

[1]L. Bai, W. Ge, X. Chen, Q. Tang, and R. Xiang, "Landing Impact Analysis of a Bioinspired Intermittent Hopping Robot with Consideration of Friction," *Mathematical Problems in Engineering*, vol. 2015, p. 374290, Jul. 2015, doi: 10.1155/2015/374290.

Section 5-6: Firmware and Software — *Using Where Lists*

List is at least 3 items long.

Example 1.

No primary heading.

where

Left hand side indented one em space.

$$\gamma_7 = \gamma_8 + \gamma_{10} - \gamma_9 = f_3(\gamma_2), \tag{8}$$

Each item ends with a semi-colon.*

$$A_f = 2 \cdot l_3 \cdot l_{10} \cdot \sin\gamma_9,$$

$$B_f = 2 \cdot l_3 \cdot l_{10} \cdot \cos\gamma_9 - 2 \cdot l_6 \cdot l_{10}, \tag{9}$$

$$C_f = l_{10}^2 + l_6^2 + l_3^2 - l_5^2 - 2 \cdot l_3 \cdot l_6 \cdot \cos\gamma_9.$$

Last item ends with a full stop.

Z. Zhang, B. Chang, J. Zhao, Q. Yang, and X. Liu, "Design, Optimization, and Experiment on a Bioinspired Jumping Robot with a Six-Bar Leg Mechanism Based on Jumping Stability," *Mathematical Problems in Engineering*, vol. 2020, p. 3507203, Jan. 2020, doi: 10.1155/2020/3507203.

Section 5-6: Firmware and Software — *Using Where Lists*

Where Lists: Where lists define variables in the equations preceding the list. They are characterized by incomplete sentences and follow the same rules as *Nomenclature* lists, with the following exceptions.

1) There is no primary heading.
2) The left-hand side is indented one em space.
3) The first letter on the right-hand side is lowercase.
4) Each item ends with a semicolon (except for the last item, which ends with a period).
5) The lists are at least three items long; if fewer than three items, the list is generally run in paragraph form.

Example:

where

Δv_S $= \Delta V_S \cos(\omega' t + \phi')$;
ΔV_S amplitude of supply voltage flicker;
ω' angular frequency of supply voltage flicker;
V_{Sf} supply voltage amplitude;
ω supply angular frequency.

Note the alignment of the equal sign with the right-hand side.

IEEE Editorial Style Manual For Authors, 2019, IEEE.
http://ieeeauthorcenter.ieee.org/wp-content/uploads/IEEE_Style_Manual.pdf

	Checking your Numbered Lists	**Example**	✓
1.	**Have you** provided a signal phrase?	The results of XXX are listed below:	
2.	**Have you** have you used the correct punctuation at the end of your signal phrase? • Complete sentences (end with a colon) • Incomplete sentences/clauses (no punctuation)	The results of XXX are listed below: Students must complete the project using	
3.	**Have you** organised your information in the correct sequence?		
4.	**Have you** ensured that there are no more than 8 items in your list?		
5.	**Have you** used a parallel structure for all items in the list?	1. The motor drives the rotation of the.. 2. The sensor sends a signal to the…	
6.	**Have you** indented the items on the list so that the sequence of numbers is apparent? Only necessary if the items on your list runs into a second/third line.		
7.	**Have you** provided an analysis of the list (necessary if you list items/steps without explanation.	1. Initialisation 2. Power on	

Section 7: Lessons Learnt and Conclusion

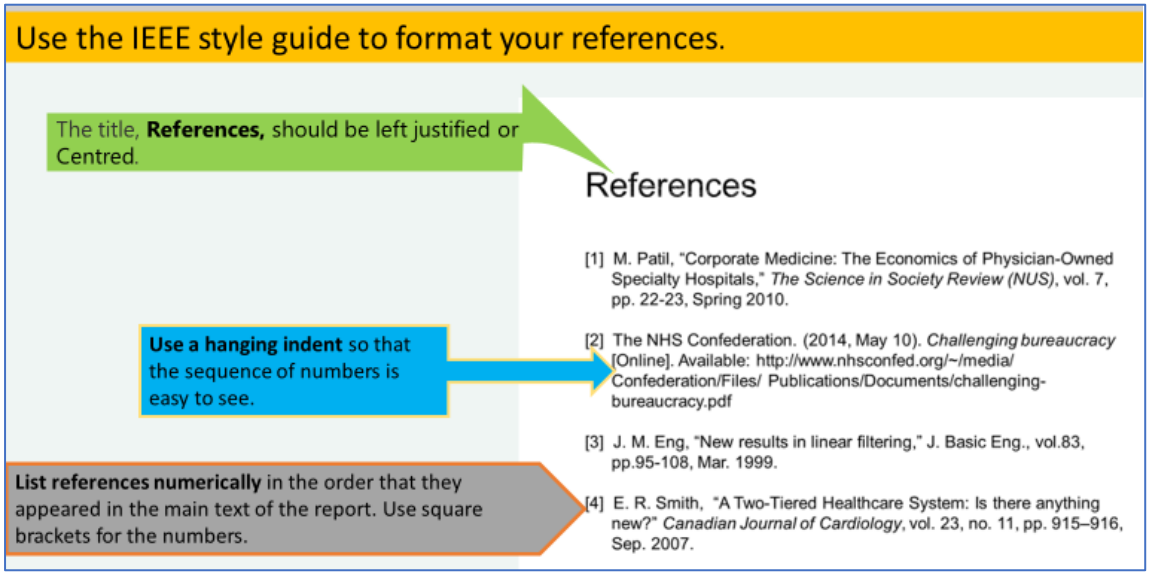
The Project Design Report did not include a Conclusion so you will need to write the Conclusion for the Final Design Report from scratch.

As the actual project is in its final stages (not yet completed), it is likely that you will find it difficult to reflect on their biggest mistakes or lessons learnt.

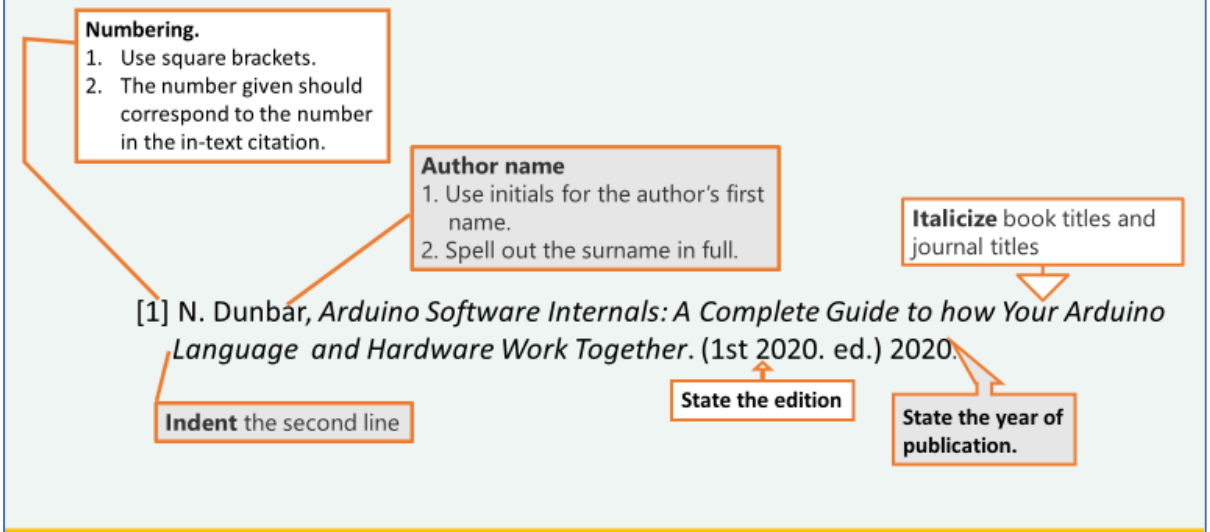
As you complete your Alex, make specific notes of your struggles and your successes. This will make this concluding section of the Report easier to complete.

Section 7: Lessons Learnt—Conclusion	***Evaluating and assessing***
1. **Overview:** Begin with an overview statement that sums up your original project goals. This project aimed to…	
2. **Two difficulties** Follow this with a reflection on the difficulties (hence mistakes) you encountered. As this is a technical report, you should try to describe technical problems and setbacks. You may include a technical difficulty you had initially that you then resolved. If you do this, you could describe the technical resolution to your problem in the final part of the conclusion.	
3. **Two lessons learnt** As this is a technical report, you should try to describe technical lessons you have learnt.	
4. **Conclude** Say what you would do differently if you had the opportunity to do the project again. Link these ideas with the difficulties and lessons you mentioned earlier.	

Back Matter: References



A quick guide to IEEE Referencing



For more help on IEEE references
See: https://libguides.nus.edu.sg/c.php?g=145626&p=955413 OR
https://libguides.murdoch.edu.au/IEEE/home

Back Matter: Appendices

Back matter: 2. Appendices

The length of the information should determine whether to create an appendix. If the information is long (more than ½ page) and will distract the reader from the focus of the report, place it in an appendix.

Type of appendices:

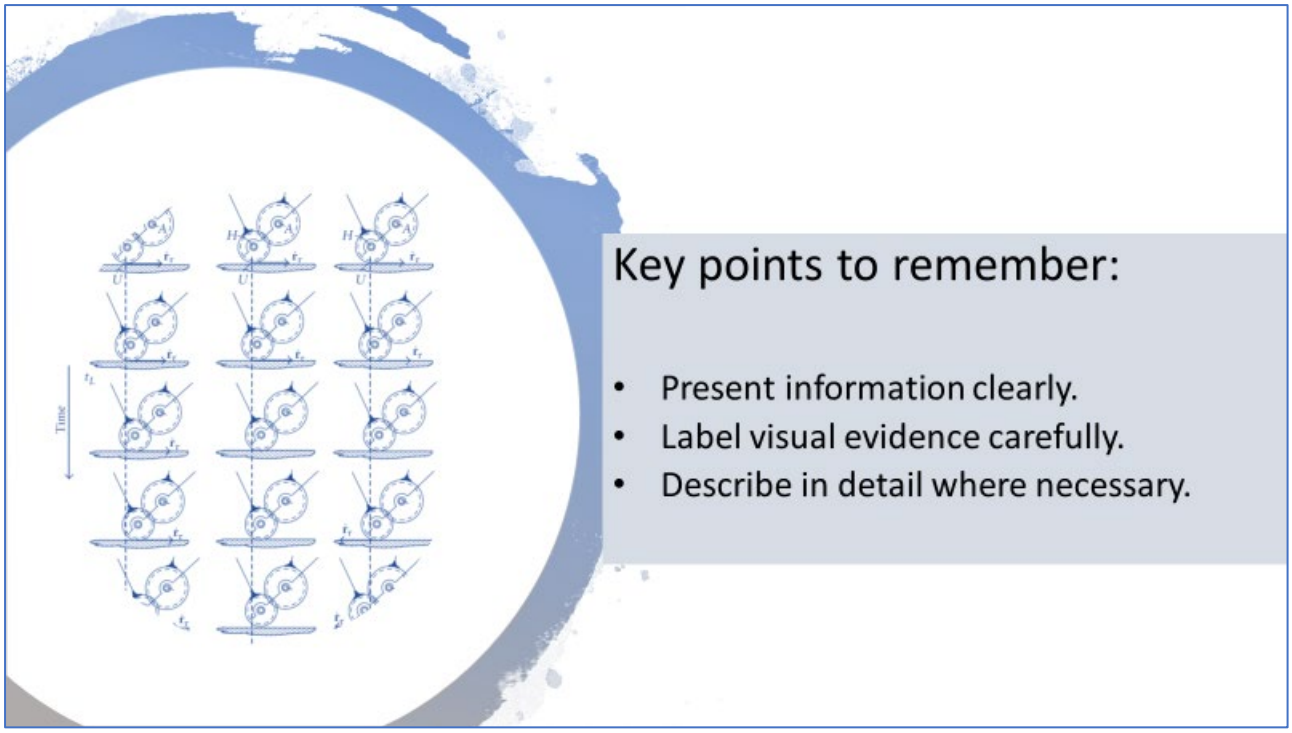
- Gives background information to help a less technical audience understand the report.
- Gives information that would be too detailed for the main story of the report.
- Gives information which is not directly relevant to the focus of the report, but interesting for readers.

For proper transitions, you should mention each appendix at least one time in the document before that appendix appears. In other words, when the connection to the information arises in the text, refer readers to the appropriate appendix.

Appendix

Refer to the Appendix in text as "given in the Appendix." Note that the plural of Appendix is Appendixes. Also note that all figures and tables in the Appendixes must be labeled in consecutive order with the other figures in the article.

IEEE Editorial Style Manual For Authors, 2019, IEEE.
http://ieeeauthorcenter.ieee.org/wp-content/uploads/IEEE_Style_Manual.pdf



A note on Plagiarism
Reports that are plagiarized will be penalized. Students who plagiarize will face disciplinary action. *It does not matter if the plagiarism is deliberate or unintentional.*

What is Plagiarism?
• Presenting someone else's ideas or work as your own. • Copying chunks of text or images from a source and changing only a few words or elements • Re-using your own work or your peer's work from a different module.

How do you avoid plagiarising?
• Use the required citation style (IEEE) to cite all your sources. E.g.: Scholarly books, papers, lecture notes, lectures, and all online sources regardless of how generic they might be.
• Remember to provide citations for images that do not belong to you.

Preparing for the Peer-review Workshop

1. Find out which team you will exchange your report with by **7 April.**

2. Upload your draft of the Final Report on Google Docs **(by 7 April).**

3. Allow your CELC tutor and your Peer-reviewers access to your Doc. by sharing the link with them.
   When you share the link, give permission to comment rather than edit.

4. *You are allowed to redact formulas and algorithms from your report. However, this will leave 'gaps' in your report and make it difficult for your Peer-reviewers to provide informed feedback.*
   Try to minimise redactions in your Report.

WEEK 9
9 APRIL
WORKSHOP 2

Peer-review: Evaluate another team's Final Design Report

Preparations for peer-review

1. Upload your Design Report to the Google Docs. Folder.

2. Share the link for the folder with your reviewing team and your CELC tutor.

3. Remember to allow reviewing teams to ***Comment*** on the Google Docs.

4. Read the Report ***before*** the peer-review session.

5. Download the Final Design Report Peer Review form.

   Files> CELC Workshops