Faculty of Engineering
Final Year Project

Writing the Research Paper

These items form a general guide based on information provided by the Department of Mechanical Engineering. While the information contained is generally applicable to most engineering research papers, emphasis may vary according to your particular field and your project type. Refer to your supervisor for more specific information. Your supervisor is the primary authority in all matters relating to the project and the related assessment tasks.

Research Papers
- are the primary forum for communicating new research to others in your field
- are written for researchers and other professionals in the field
- are written in the register (linguistic style) of the discipline

Purpose of the FYP assessment task
- To present a specific aspect of your original work to an expert audience
- To learn how to write a research or technical paper in your field
- To demonstrate your ability to write concisely with precision and accuracy

Getting started
Decide on your aim and scope
The first step is to establish a feasible aim and scope. The subject of a paper is often one element or step within a larger project. The brief format of a research paper is suited to detailed presentation of a single objective with a relatively narrow scope. Therefore, the first step is to decide exactly what you want to inform your readers about, and clearly define your scope.

A good way to decide is to consider what aspect of your project was particularly interesting, original, enlightening, exciting, or surprising.

Once you have decided, write a title and aim statement specifically for the research paper.
Plan your paper with the second marker in mind. This may be the only document the second marker will see to assess your performance in the Final Year Project. Consider how much background knowledge he or she is likely to have in your field of study, and how much you will need to include in the Introduction to your paper.

Decide how to present your results
The next step is to create or select the graphs, tables, photos, diagrams or other figures which will form the basis of your Results section. Space is limited; you should aim for no more than about six, so it is essential that each demonstrates a significant aspect of your results. You may need to devise some figures specifically for the paper rather than use those you made for the final report or thesis. You can combine more than one piece of information on a single figure, as long as it remains clear and easy to ‘read’.

For a conference paper entitled *Image Overlapping to Improve Micro PIV Accuracy*, out of more than 100 results graphs, the following five figures were selected or especially compiled:

**Project Aim:**
To investigate the bond behaviour of stirrups used to anchor reinforced concrete T-beam bridges.

**Project Stages:**
1. Review early T-beam construction methods and materials
2. Examine shear behaviour of T-beams with stirrups
3. Determine variables affecting bonding behaviour
4. Experimental testing of scaling and bond behaviour
5. Test ability of nonlinear finite element modeling to predict bond behaviour

**Research Paper:**
**Title:** “The effect of beam scale on bond behaviour”
**Aim:** To present the results of experimental testing of bond behaviour with full-scale and half-scale beams.
Figure 1. Schematic showing the optical setup for micro PIV of channel flow. The velocity profile is shown as a parabolic curve. The focal plane is located at the centre of the channel. Particles further from the focal plane appear larger and dimmer and the strength of the corresponding peak of auto-correlation decreases. The depth of correlation, $\delta z_{corr}$, is defined as the distance over which the peak of the auto-correlation is above 1% of the auto-correlation at the focal plane. Due to the variation of particle correlation signal over $\delta z_{corr}$, the measured velocity is a weighted sum of velocity variation within the depth of correlation.

Each figure or table must be numbered sequentially. The caption should indicate the figure type, if other than a table or graph, (optical microscope image, cross-section, etc) and state what it shows.

In medicine-related fields, such as Biomedical Engineering, captions tend to contain detailed information about the content, as shown above.

In other Engineering fields, it is more common to give the figure a brief title, and describe the content in the text of your paper, as shown below.

... The change of the particles and their correlation signals with respect to the depth or z-direction is illustrated in Figure 1. The velocity profile is shown as a parabolic curve, and the focal plane is located at the centre of the channel. Particles further from the focal plane appear larger and dimmer and the strength of the corresponding peak of auto-correlation decreases. The depth of correlation, $\delta z_{corr}$, is defined as the distance over which the peak of the auto-correlation is above 1% of the auto-correlation at the focal plane. Due to the variation of particle correlation signal over $\delta z_{corr}$, the measured velocity is a weighted sum of velocity variation within the depth of correlation.
Planning the other sections
Plan the Introduction, Method, Discussion and Conclusions in point form, as shown below.

The performance of correlation averaging can be improved by image pre-processing as shown in Figure 3b. When an optimized band-pass filter is applied prior to correlation averaging, $\mathcal{E}^2$ norm drops from 8.25px to 6.06px. The improvements in velocity measurement are most significant in the flow centre. While there is some improvement in the accuracy of measurements adjacent to the wall, there is still significant deviation from the exact velocity profile in the near wall region.

Check that you have included everything you need to say at each stage, and that your notes are ordered logically and make sense. You can then write from your notes without danger of repetition or ambiguity.
The basic structure of a research paper is shown in sample A. below. While the order of information is standard, you do not need to adhere rigidly to the headings between Introduction and Conclusions. The theoretical background may be included in the Introduction, or given its own section. Remember, the main point is that the paper develops logically.

A. Mechanical Engineering FYP template

B. A typical research paper outline

C. A typical research paper outline

D. A typical industry based project outline

Introduction
- introduces the topic in context
- states the aim and scope of the research
- provides relevant theoretical and technical background information
- briefly outlines the content/purpose of the report
Particle Image Velocimetry (PIV) is a technique that has been used for over two decades to obtain instantaneous velocity fields. It began in 1977 with studies in laser speckle velocimetry (LSV) [1], which used double exposure photographs, planar laser illumination, and interrogation through the formation of Young's interference fringe patterns from displaced laser speckles. Advances in the field led to particle image velocimetry (PIV). Standard PIV systems consist of a laser light sheet (typically a Nd:YAG laser), illuminating flow sections with images captured by digital cameras (CCD cameras) [2], [3] or in some cases photographic film [4].

More recently, the rapid increase in the use of microfluidic devices has led to microscopic particle image velocimetry (MPIV) [5]. The flow is seeded ... difficult to produce a light sheet thin enough for the micro-channel due to the smaller length scale. One drawback ... is the effect of out-of-focus particles [6]. Another is the noise level in ... [5]. The particle seeding density becomes a limiting factor to measurement accuracy since .... This reduces the visibility of the in-focus particles on the image and hence reduces the measurement accuracy greatly. Lower seeding densities can reduce the resolution of measurements obtained [6].

Many microfluidic flows are typically steady, low Reynold's number flows which can be well represented by time-averaged measurements [7]. This paper outlines the current methods used to obtain time-averaged velocity measurements and presents a new technique that combines aspects of the current methods to obtain a more accurate measurement. It is shown that this alternative algorithm provides greater measurement accuracy than can be obtained using existing methods alone.

Note how the writer situates the topic, MPIV, in the context of its historical development, which leads naturally to the motivation for the current work, the limitations in the current technique which reduce measurement accuracy.

Note also how the aim of the research, is not specifically stated, but that this becomes clear in the final two sentences which outline the content and purpose of the paper.

**Conclusions**

- Recaps your key results, highlighting their significance in relation to your aim/s.
- Briefly acknowledges limitations in your work
- Makes brief recommendations where appropriate

The new VPIV algorithm, which incorporates the effect of particle concentration, is shown to significantly improve the accuracy of velocity measurements, while also providing particle concentration profile with good accuracy. At each location within the image, a velocity profile in the out-of-plane direction can be obtained, instead of the single velocity vector produced by standard PIV techniques. In additional to velocity measurement, the extended VPIV algorithm can also measure particle concentration profiles in the out-of-plane direction, which has not previously been achieved using a single image plane. Numerical validation shows that the concentration measurements can be obtained with good accuracy. Such concentration information is valuable in studies of particle interaction with walls, such as thrombus formation in blood arteries.

**Abstract**
- Briefly outlines the topic, aim and method
- States key results in logical order

The key function of the Abstract is to attract interest and inspire a prospective reader to read your paper. The first sentence should therefore catch the reader’s attention.

Current emphysema detection methods do not allow for early identification of the disease, with the result that, by the time diagnosis is confirmed, lung damage is irreparable. This paper presents a novel, low cost acoustic technique in which changes in the dispersion and attenuation of low frequency sound are used to detect lung damage associated with microscopic emphysema. Latex and foam models were used as lung analogs to study the effect of permeability on acoustic properties. Measurements of propagation velocity and attenuation were made using the standard impedance tube. The results show the increase in velocity and attenuation as a function of frequency as well as the relationship between attenuation and permeability as predicted in theory. Measurements on latex using the pulsed sine technique agreed with the results from the impedance tube method, and hence support the theory. The results of the project also suggest that the material physical parameter, tortuosity, rather than velocity, could be used as the detection principle for microscopic emphysema.

Types of Abstract
Descriptive: describes the type of information presented in the report only – may be used for a paper to be presented at a conference to attract an audience
Informational: summarises the actual information presented in the report focusing on results – suitable for a research paper to be published in a journal
Combined: contains some quantitative information; eg, results, and gives descriptive information about the rest of the report content

(Michaelson 1990)

Below is the abstract from the paper on microscopic particle image velocimetry
Can you identify the type from those listed above?

Volumetric-correlation particle image velocimetry (VPIV) is a new technique that has significant advantages over other 3D velocity measurement techniques: it provides a 3-dimensional 2-component velocity field from a single image plane. Here we further develop this technique adding the capability to measure concentration. Particle concentrations were measured using the auto-correlation map. The velocities were calculated using the cross-correlation and the measured particle concentration. The results show significant improvement in the accuracy of velocity measurements in addition to the ability to calculate the particle concentration profile. The 3D-velocity and particle concentration measurement capability of VPIV is demonstrated using both synthetic and experimental results.

Your final year project research paper abstract should be Informational or Combined. Make sure it contains actual information, in particular your results.

Language Focus: Editing your drafts
Once you have written your first draft, review asking yourself the following questions:
Does your text say precisely what you mean?
Is your text cohesive, with clear reader directions and linking?
Is your writing style professionally objective and technical?
Is your writing grammatical and correctly punctuated?

Look at the draft Introduction below. What changes could you make to improve the writing?

All structures, along with their components, are subject to impacts in their working life, for example during maintenance. It is important that the reduction of performance of the structures and components due to impact is not significant, and to ensure that the structure remains safe. When such accidents occur, it is important to be able to accurately measure the material damage which has been done, and any resulting loss in strength or stiffness (modulus). The present study will experimentally consider the damage tolerance of GRP (glass reinforced plastic) composite structures.

a. Unnecessary words: in their working life; which has been done
b. Illogical structure: “It is important that the reduction of performance of the structures and components due to impact is not significant…” interrupts the ‘flow’ of the text and is repetitive.
c. Repetition: …it is important…
d. Structural gap: The Introduction leaps from the importance of ensuring safety after impact damage (general background) to establishing the damage tolerance of GRP (specific topic and aim) without any connecting remarks.
e. Incorrect abbreviation form: GRP (glass reinforced plastic)

Consider the revised draft below:

All structures, along with their components, are subject to impact, for example during maintenance or extreme weather events. When such accidents occur, it is important to be able to accurately measure material damage, and any resulting loss in strength or stiffness (modulus), to ensure that the structure remains safe. In recent decades, many high-strength composite materials have been developed, which significantly decrease instances of reduction in performance due to impact damage. However, these materials do not all perform to the same standard. The present study will experimentally consider the damage tolerance of glass reinforced plastic (GRP) composite structures.

a. Unnecessary phrases removed
b. Background more firmly established with extra example of causes of impact (or extreme weather events.)
c. Structure: Majority of disrupting sentence removed, final clause added to next sentence (to ensure that the structure remains safe.)
d. Structural gap filled: New composite materials introduced and limitation defined (do not all perform to the same standard.)
e. Abbreviation corrected: glass reinforced plastic (GRP)

Below is a draft Introduction to a paper on desalination techniques. See how the draft changed with each review:
Water shortage is currently an issue greatly concerning Australia, which the government has been trying to overcome for several decades, policies and regulations being two means. Engineering solutions have come up with desalination as one possibility, which involves getting rid of salt and other dissolved minerals from sea water to make it drinkable.

Australia’s water shortage is an issue of increasing concern to environmentalists, politicians and the general public. However, while the government is juggling the distribution of existing water supplies, engineers have been busy coming up with technological solutions. One of the most widely accepted of these is desalination, which involves the removal of salt and other dissolved minerals from sea water to produce potable water.

Citing and Referencing
You will be expected to cite and reference your source material correctly. See:
- The Library’s online tutorials (http://www.lib.monash.edu.au/tutorials/citing/)

Resources
Reporting the 4th Year Project
Engineering Online Resources

Reference
Michaelson, HB 1990, How to write and publish engineering papers and reports, 3rd edn., Oryx Press, Phoenix AZ.