AAE 520
EXPERIMENTAL AERODYNAMICS

REPORT FORMAT

Purdue University
School of Aeronautics and Astronautics

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For use in AAE 520 - Experimental Aerodynamics

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GENERAL LAYOUT

The final draft of the lab report should be a concise, legible, well-organized description and explanation of the experiment performed. The best way of achieving this result is by using a standard format each time a laboratory report is written. Below is a simple format commonly used to communicate the procedure and results of experiments. This is the format you will be asked to use throughout this course:

Cover Page
Abstract
Introduction
Background
Procedure
Analysis of Results
Discussion and Conclusions
References
Appendices

COVER PAGE

The cover page should show the title of the report, the student's full name, course and year, and the name of the professor as appropriate

ABSTRACT

The abstract should give a short summary of the purpose and results of the experiment and be complete in and of itself. The reader should not have to read the paper to understand the abstract. This section is typically about 200 words long. No actual numerical data should be presented in this section, unless this data is the key in the experimental results. The abstract should indicate the subjects dealt with in the experiment and should state the objectives of the investigation. Newly observed facts and conclusions of the experiment should be stated in summary form. Usually, the abstract is more easily written after the other sections of the report, since this is a "mini summary" of the report itself. Keep in mind that the abstract of most reports are read and only the reports in which the reader believes contain useful information (based on the abstract) is more thoroughly read.

INTRODUCTION

The introduction presents some information as to why the experiment is being performed in the first place. This section should outline the purpose of the experiment as well as the intended method to achieve the desired results. Reasons for these decisions should also be included.

BACKGROUND

This section contains a description of the work done to prepare for the experiment. This could include research into the history of the particular experiment, or it could contain some calculations necessary for the successful completion of the laboratory experiment. Theory related to the experiment and previous work on which the experimental work is based should also appear in this section.

PROCEDURE

This section should include enough information such that the experiment could be reproduced by someone knowledgeable in the field. Explain the procedure in your own words. Do not give a cookbook style description of the procedure (i.e. do not use present tense). Explanations of why one procedure was chosen over another should also be included.

A good schematic is very helpful in showing the general layout of the experiment. This should be more than just a block diagram of the components; it should represent the experiment and contain labels of all the equipment. Use a straight edge to draw straight lines and make all the electrical wire connections rectangular. Complete names of all the important pieces of equipment should be given. Schematics are figures and therefore must be treated as figures and contain a figure number and caption.

ANALYSIS OF RESULTS

Here, **YOUR** interpretation of the data is presented. All qualitative observations made in the laboratory should be stated in this section as well as all of the data collected if short (lengthy data may be placed in an appendix). This section may be broken into parts as follows if the experiment lends itself to this format:

Data Reduction

An outline of the data reduction used should be included, with reference to simple calculations. The calculations presented in this section need to be kept brief (lengthy calculations may be placed in an appendix). Showing the equations used in the data reduction process is useful in conveying your ideas and the method employed.

Comparisons

Tables, graphs, etc. are to be placed in this section for comparison purposes. This allows specific parts of the data to be easily located and interpreted by someone unfamiliar with the experiment. All graphs, plots, etc. must be interpreted in this section. Comparisons with the expected results, theoretical results, or other experimental results are also placed here.

DISCUSSION AND CONCLUSIONS

This section is for the evaluation of and the reflection on the experiment and results. This section may also be broken up into parts if helpful.

Conclusions

Concisely stated conclusions which are drawn from the experimental results and a discussion of them in terms of the original objectives of the experiment are to be included in this section. Some general conclusions extrapolated from the specific results of the experiment should also be drawn. When a conclusion is drawn, make sure that the supporting results are plainly stated in the preceding sections. Also, when discussing experimental deviations, avoid placing all the blame on "experimental error" or equipment malfunction unless this is really the source of error.

Limitations

All good laboratory reports contain an honest discussion of the limitations of the experimental methods as well as those of the theory. Only when a clear understanding of the experimental methods, the theories used, and the data analysis methods is obtained, can these limitations be expressed. At this point, the engineers involved in the experimental analysis are capable of determining if the data obtained are useful for further research or just "garbage." Suggestions and recommendations for improvement are definitely in order.

Error Analysis

An error analysis must be included in every report for completeness. MATLAB is very convenient for error analysis since many of the error analysis processes are already programmed as functions in MATLAB. Be sure to examine the data for consistency, perform a statistical analysis of the data where appropriate, and estimate the uncertainties of the results.

REFERENCES

The accepted format for this class will be the format used by the American Institute of Aeronautics and Astronautics. List and number all the bibliographical references at the end of the paper. When referring to them in the text, type the corresponding reference number in superscript as shown at the end of this sentence.[1] This format is presented below:

Books

Turner, J. M., Martin, H. C., and Leible, R. C., "Further Development and Applications of Stiffness Method", Matrix Methods of Structural Analysis, 1st ed., Vol. 1, Macmillan, New York, NY, 1964, pp. 203-266.

Journals

Griffin, J.L. and Sherman, P. M., "Computer Analysis of Consideration in Highly Expended Flows", AIAA Journal, Vol. 3, No. 10, Oct. 1965, pp. 1813-1819.

Reports

Book, E. and Bratman, H., "Using Compiler to Build Compilers", SP-176, Aug. 1960, Systems Development Corporation, Santa Monica, CA.

Proceedings

Soo, S. L., "Boundary Layer Motion of a Gas-Solid Suspension", Proceedings of the Symposium on Interaction Between Fluid and Particles, Institute of Chemical Engineers, Vol1, 1962, pp. 50-64.

APPENDICES

This section contains all supplementary material referred to (even indirectly) in the report. It contains such items as raw data and graphs, sample calculations, and, in general, anything that would clutter-up the report if it were located elsewhere. It should begin on a new page.

WRITING THE REPORT

While there are many ways to get a report written, the following has proven very successful and is used by many writers.

Within a few days of performing the experiment, make a rough draft of the report. That is, without worrying about grammar, spelling, neatness, etc., *but using the given format*, write as much as you can. Any and every idea that occurs to you, write it down. Additionally, make a list of difficult points, etc. Spend about one to two hours on this and then leave it.

Over the next few days, see your instructor, teaching assistant, or someone in your group and discuss the difficult points with them. Also work on the analysis at this time. Then go back to the draft and rearrange the material, filling in the blanks, scratching repetitions, etc. Only when all of this is done, should the final draft be written.

Remember that the most important part of the report is the analysis and this is where most of the effort should be spent. Also, an average report should take about six hours to write and should be about ten pages of text, not including figures and appendices.

GENERAL COMMENTS

The key word for these laboratory reports is *professionalism*. You will be evaluated by the quality of your work. When handing in these reports, consider the following question: Is this the quality of work that you would turn in to your boss?

Although all of you are engineers, it is assumed that you have the writing skills appropriate for college graduate students. A large portion of the points assigned to the reports will be based on your ability to convey what you have learned in a clear, concise, and reasonable manner.
These lab reports should be stand alone documents. Do not assume that the reader has the laboratory handouts for reference. This is why it is important that you state how you obtained your results. Great detail is not required, just a brief explanation.

Neatness is very important. It is very difficult to follow a messy report. If the report cannot be understood, the report is useless.

It is not necessary to type the reports, but typing is preferred. A well structured, neatly written report is perfectly acceptable. No points will be added or deducted for type written or hand written reports.

Any graphs (unless specifically stated otherwise) must be done on a computer or graph paper. These graphs, plots, etc. should be properly labeled and discussed.

HELPFUL HINTS

The following is a collection of some DOs and DON'Ts related to report writing:

General

Use regular (standard) white paper for the report text.
Staple the report together or use some other neat binding method.
Be neat in every aspect of the report.
Use third person passive for the voice and mood of the report.
Past tense is used for explaining procedures, and present tense is used for generalizations and for stating what the results show.
Whenever practical, use lists. Give the lists visual emphasis by using bullets.
Use headings and subheadings to guide the reader through the organization of the report.
Do not put headings on separate pages.
It is not necessary to start each section on a new page, although this is sometimes convenient

Do not put quotation marks around titles.
An Index or Table of Contents is not necessary; a List of Figures may be included though.
Do not repeat section titles on new pages [e.g., Introduction (cont'd)].
Make sure the sketches and figures are large enough to be clearly seen.
Do not number pages 1 of 10, 2 of 10, etc.
Do not refer to material by page number.
Never end a section with an equation.
Do not use first person or such words as "them", etc.
Do not refer to "the student."
Do not address the reader [e.g., " You will then..."].
Do not mention personal names except such cases as "Bernoulii's equation."
Avoid phrases like "please refer to...."
Do not give particulars about the lab arrangement [e.g., "... our group did this while..."].
Put long derivations of equations in an appendix.
Do not use footnotes if at all possible, use end notes instead.

Procedure

If describing the procedure becomes lengthy and difficult, use a flow chart for clarification.
Avoid the phrase "the lab began with...."
Do not write "the... was demonstrated" unless it is elaborated on.

Results

Never end or begin a section with an equation or numbers.
Use complete sentences when describing the analysis, not just numbers or equations.
Unless the flow is not disturbed, put sample calculations in an appendix.
When dealing with the experimental data reduction, always use the experimental values even if theoretical values are available.
Refer to figures by figure number, not page number.
Number figures in the order they are mentioned.
All figures must be captioned.
Make figure captions descriptive.

Conclusions and Error Analysis

Conclusions and recommendations answer the question: So what?
The significance of the work is stressed here.
Your opinions of the experiment should be voiced in this section.
Systematic error is defined as: reproducible inaccuracy introduced by calibration or technique. Sometimes this error is correctable.
Random error is indefiniteness of result due to finite precision of the experiment. Also defined as the measure of the fluctuations in the results after repeated experimentation.
Accuracy is a measure of how close the result of the experiment comes to the "true" value.
Precision is defines as: a measure of how exactly the result is determined without reference to any "true" value.

Numbers and Symbols

Do not have too many digits in the results; the listed results cannot be more accurate than the instrumentation and procedure used to obtain the results. (Usually only one more digit than easily read from the instrument is acceptable.)

Use 10^{-6}, 10^{-3}, etc., or the named equivalents.

Tables are TABLEs, not figures.

Tables must have captions and table numbers.

Beware of units.

For a given difference, the smaller base gives the higher percentage.

A difference is not an error.

Percent error is defines as:

Round the error to $\pm$3% instead of writing $\pm$3.16%.

Error in reading is [error in scale]/[total scale].

In the mathematics, wherever feasible, use the solidus for fractions.

Omit all radical signs and use instead parentheses with an exponent, or if radical signs are necessary, be sure they are neat and easily read.

Handwritten symbols should be carefully written.

Identify Greek letters and unusual symbols.

Graphs and Figures

All figures, sketches, graphs, diagrams, photos, etc., are called Figures in the report and must have a number and a descriptive caption.

Use proper graph paper for graphs.

Number figures 1, 2, 3, etc., not One, Two, Three, etc.

Center graphs on the page; do not draw to the edge of the sheet.

Do not fill the complete page with the graph (unless it is to be reduced).

Make the graph so that the eye can grasp it, e.g., about 5" x 5".

Label axes and place labels parallel to axes.

The independent variable is placed on the horizontal axis -- dependent, vertical.

Do not have scales too sparse or too dense.

Make sure the scales are balanced.

Use 10^{3}, 10^{-3}, etc. for scales when needed.

Captions should be descriptive, not just repeats of labels.

Figures must be referred to in the order of numbering.

Never indicate data as tiny dots -- use symbols.

Use separate symbols for separate sets of data (even if they are expected to be the same).

Use a curve fit (or a continuous line) to represent theory, not symbols.

Do not connect the data points unless the law is known.

When possible, put comparable data on the same graph.

Never put data outside the range of the scales.

Document or label all curves on a graph.

Put experimental and theoretical curves on the same graph.

When data follows an obvious law then graph a best fit curve as well (1st, 2nd, 3rd degree polynomial fits, trigonometric curves, etc.).

If a comparison is made between two different graphs, then they should have the same scales.

Language

Avoid abbreviations such as *don't*, *isn't*, *vs.*, *it's*, *you're*, etc. (contractions in general).
Avoid pseudo quantitative words such as *fairly*, *nearly*, *very*, *great*, *easily*, *lots*, etc.
Use connectives sparingly. Connectives are *then*, *now*, *we are now in a position to*, etc.
Make the language simple and straight forward.

Poor	**Better**
unhandy	unsuitable
linear curve	straight line
comes out very linear	is linear
telling us	indicating
pretty much tells the story	indicates or demonstrates
thirty pounds	30 lbs.
gage three	gage 3

Spelling

Certain words are always being mis-spelled. A partial list is:

alignment, accurate, actual, apparently, attention, assuming
beginning
circuit, compare
deviate, derivation, discrepancy
extreme, equal, examine, either
familiarize, factor, fundamental
gripped
high light, highlight
irrelevance
justifying
knife-edge
likelihood, lens, lenses
measuring
nullifying
oscilloscope, occur
parallel, particle, principle
qualitative
refer, reciprocal, rigid
specimen, symmetric
theoretical, transmit
using, useful, usefulness, until
vacuum, versus
write-up
yield
zeros

Always use a spell checker of one form or another, or have someone read over your report.

REFERENCES

The following resources might prove useful for further questions:

Mentzel, D. H., Jones, H. M., and Boyd, L. G., Writing a Technical Paper, McGraw-Hill, New York, NY, 1961.

van Leunen, M., A Handbook for Scholars, Revised Edition, Oxford University Press, New York, NY, 1992.

Ehrlick, E., Punctuation, Capitalization and Spelling, Schaum's Outline Series, McGraw-Hill, New York, NY, 1977.

Day, R.A., How to Write & Publish a Scientific Paper, Oryx Press, Phoenix, AZ, 1994.

Doyle, J. F., A Document on Report Format, Purdue University, West Lafayette, IN, used in class work involving structures.

Burke, M. J., "AAE 421L Report Format", Purdue University, West Lafayette, IN, used in assisting teaching for structures laboratory.

Roget's Thesaurus.

English Dictionary.

The last two are an essential pre-requisite for intelligible writing and are indispensable when your vocabulary is drying up.