BEE/MAE/ENGRC 4530
Communication Component:
Writing Guide

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See also http://chec.engineering.cornell.edu

Table of Contents

1.0 Report Writing Conventions

Conventions are typically understood to be contextually standardized ways that documents or parts of documents appear. Another way to refer to these conventions is as "manuscript requirements." Conventions are important because they represent audience expectations. And, those expectations range from the seemingly trivial (such as the design of a title page or the customary spelling of words or the format for citing reference works) to the very significant (such as dividing a particular text into its respective sections or labeling visuals and integrating them into texts or determining the order and information appropriate for appendices).

Research articles in engineering, history, literary studies, and/or philosophy follow different conventions. Similarly, a technical report presented to an agency that has granted research funds to a university may follow different conventions than a technical report presented to a supervisory committee of a particular company concerning the development of a product. However, it is critical to understand that both reports will need to follow the conventions relative to their context. Because those conventions represent audience expectations, if you do not write with those conventions in mind, it could result in audience confusion, or much more seriously, in audience rejection/ denunciation of your research.

Some conventions are simply arbitrary, for example, title page design. Other conventions may facilitate understanding, for example, the sequencing of the methods, results, and discussion sections in order to recreate the research/discovery process. One of the first activities for all authors, when writing a document with which they are not familiar, is (or certainly should be) to attempt to determine the appropriate conventions.

Some parts of this writing guide has been updated to reflect the "**Reporting of Computational Modeling Studies in Medical Device Submissions**: **Guidance for Industry and Food and Drug Administration Staff"** released in September 2016.

1.1 Required Formatting for the 4530 Report

- Title page
    - Title, top, centered, 18 pt Times New Roman (TNR) font
    - Keywords: Five keywords, separated by commas, 12pt
    - Course name and number, also centered, 12pt (just below and skip one line)
    - Names of the research team members, 12pt
    - Date submitted, 12pt

- Table of Contents
    - Use the Table of Contents generator in MS Word.

- o Each section should have both a number and a worded heading. Example:

    1.0   Executive Summary

- Section Headings
    - o Follow a consistent heading style. For example
        - Each section heading should be justified left and bold
        - Skip one line in between the heading and the first paragraph of that section
        - Within each section indent at the beginning of each paragraph, 12pt font TNR.

- Subheadings
    - o All subheadings should follow a consistent style.
    - o For example, italics 11pt font could be use.
    - o Continue the numbering system. For example, in Section 2.0, and subsections would be 2.1, 2.2, 2.3, and so forth.

- <mark>Appendices (Required)</mark>
    - o Appendix A: Mathematical statement of the problem
        - Geometry or schematic (unless already included in the Introduction)
        - Exact form of (velocity/temperature/concentration) governing equation
        - Exact form of the initial and boundary conditions used
        - All input parameters in a table (or plot) in consistent units
    - o Appendix B: Solution strategy (Answer these issues; provide these pieces)
        - What solver was used to solve the algebraic equations?
        - How was the time stepping done (for transient problem only)?
        - What tolerance (relative and absolute) was used – explain using one of the solution variables?
          A plot of the element mesh. What type of element was used/?
        - Convergence of the solution and mesh refinement (important).
    - o Appendix C: Additional visuals
        - If not already included in the body of the text, add any important and relevant visuals, data, or derivations to Appendix
        - All visuals (both in the report and in the appendices) should be labeled following this convention – Identifier (Figure 1. / Table 1.) Title. Brief description.
    - o Appendix D: References heading, top of separate page, centered, bold
          References numbered in the order of their appearance in the manuscript using APA or IEEE citation style. Go here: http://chec.engineering.cornell.edu .

- See Chicago Manual of Style 14th edition for all composition, presentation and other details if not otherwise described in this handout.

- Overall minimal formatting requirements
  - Either 11 or 12pt font, Times New Roman font
  - One inch margins, all sides
  - Page number, X of Y format (use MS Word's automated feature), bottom center
  - Outside sources properly cited in APA or IEEE citation format
  - Spell checked the writing
  - Grammar checked

2.0 Writing and Revising Executive Summaries

An executive summary is a member of a family of similar genres (e.g., abstract). Typically, executive summaries attempt to serve two main functions or purposes:

1) to provide readers with an overview or summary of the particular document, in this case the technical report that it precedes – actually presenting briefly each of the main parts/sections of the rest of the report

2) to prepare readers by highlighting, even previewing the most important information contained in that report.

An executive summary tends to be persuasive and convincing. The authoring team must "sell" the idea that the solution and research findings were valid. The executive summary tends to stress the particular problem or issue – the impetus for the report, the results, and conclusions and recommendations.

While an executive summary does mention the research/discovery process (and/or methods, results, discussion), it differs slightly from an abstract, for instance, in that it often does not emphasize these. Because of the ways that an executive summary is designed as a "document within a document," it can sometimes prove to be a helpful tool for thinking about and beginning to write the report.

 Authors typically attempt to establish this shared understanding through a series of moves or rhetorical actions. Typically, in the technical fields, authors use the first sentence (perhaps the first few sentences) to clearly introduce the problem or issue that the report is attempting to address. In the next sentence and/or sentences, they describe the research/discovery process (and/or methods, results, discussion). Then, in the last sentence and/or sentences, the authors suggest the significance or importance of those results, outcomes. Generally, the first and second moves or rhetorical actions of an executive summary tend to be the most elaborate or developed.

See section I: Executive Report Summary in the FDA guide for more specifics. As well, the pieces for Executive Summary work in each of the specialized areas are also listed in that source:

- Computational Fluid Dynamics and Mass Transport: page 10+
- Computational Solid Mechanics: page 19+
- Computational Electromagnetics and Optics: page 27+
- Computational Ultrasound: page 35+
- Computational Heat Transfer: page 41+

Below is a brief exercise that might help you get started writing the executive summary. Writing the executive summary can prove useful as an invention (text generating) activity for the rest of the report. ***You will revisit the executive summary several times during the semester as your project matures.***

Exercise

Write a first draft of your team's executive summary. What is your project? What are you doing in order to complete that project? What are the results or the outcomes? End the summary by answering this key question: So what?

Of course, for this early drafting of your Executive Summary, teams will necessarily have to "make up" part of their work, as it has not been done yet. However, understand that teams will be revisiting drafts, updating as the semester progresses.

3.0 Writing Introductions

In technical reports, introductions tend to serve the important function or purpose of framing and contextualizing the research (often the research process) and results about to be reported. Framing establishes a shared understanding with the readers; that is, they come to know the context of your work.

Introductions in technical reports often begin with a general (but thorough) description of the nature of the real-world problem or issue that is being addressed. Introduce the context of the problem and the reasons for trying to solve it.

Presumably, this problem or issue has been addressed before, at least in part. Astute researchers and authors cover previous other approaches that have been taken to either solve that problem or respond to that issue. In some places this can be called a "literature review" because the authoring team is reviewing/vetting information from other previous work that bears upon the question at hand. Doing this work provides credibility to the research team, as it establishes that the team understands the current state of the field and previous work that informs it. You will need to cite your sources.

And, while these other approaches may have realized some success (or not), that success is only partial or incomplete. The limitations of those other approaches are also presented. Or as may be more appropriate to your situation, through modeling, you may be exploring the possibility of further research.

Either way, introductions prepare readers to understand the particular contribution that the researchers hope they can make towards solving the issue. It will not be a surprise, then, that introductions often conclude with a brief summary-- but again thorough description of the authors' current research process and of the particular and distinct contribution that the authors through this research expect to make. It is not unusual for that summary and description to include a statement of the goals, aims – the objectives – of the research.

In the literature that describes these moves or rhetorical actions, they are identified as:
1.	Establishing a territory (saying "we know what previous research addresses)
2.	Establishing a niche (saying "there is room to research something new)
3.	Occupying that niche (saying "we have a plan for that new research)

We encourage your team to identify these moves or rhetorical actions with series or sequence of headings:

> **Introduction**
> > **Background**
> > **Research Review/Literature Review**
> > **Current Research**
> > **Problem Schematic**
> > **Design Objectives**

4.0 Documenting the Research and Discovery Process

Articulating the research/discovery process is framed in technical work, typically by these basic sections: Methods, Results, and Discussion. Each of these serves a particular function.

4.1 Methods
In Methods, authors typically describe what the researchers/authors did; the purpose is to recreate the research process for the readers. If done well, readers should be able to replicate and/or validate the report's methods in new/different labs.

In the FDA guide, review carefully the expectations for researchers. Careful descriptions of system configurations are required. Also include discussion of assumptions, simplifications, and rationale for decisions with sources to back up your processes as standard and valid.

4.2 Results

In Results, authors present the outcomes of that process (only the outcomes, not the interpretation thereof). The purpose is to share the discoveries and the new knowledge that has emerged out of the Methods being applied.

4.3 Discussion

Finally, in Discussion, authors argue for (assuredly and persuasively) the significance and the importance of those discoveries and new knowledge. The purpose is to assert the real and/or potential contribution(s) that the research/discovery process has made. These are the moves or rhetorical actions associated with each of the above two sections.

4.4 Organization of these Sections

In research articles, these three genres are separated. However, it is not at all unusual for these three genres to be blended or combined in a single section of a technical report, subdivided.

However, sometimes the organization can be different. Maybe it makes more sense to share the discoveries as they occurred in the research process. Sometimes the research process itself is a very real contribution. In past semesters, students have used the heading Results and Discussion for this section of the report. Your research team should use this approach while making sure that all of the above functions are served or purposes are realized.

For specific advice, refer to the FDA guide. Below are important directives that your team should find helpful in determining what information to include in the Results and Discussion section:

- Describe the process qualitatively using the computational results obtained
- Describe the sensitivity of the process to parameter variations
- Include contour, vector, and line plots as appropriate
- Summarize important trends. Discuss these in relation to appropriate graphs and tables to clarify. Additional supporting graphs/tables can be places in Appendices.
- Use the present tense for generalizations that always apply. Employ the past tense to describe what you did and what your study revealed.
- Make sure to address these questions:
  - How do your results compare with those expected?
  - How might you explain any unexpected results?

5.0 Crafting Quality Visuals

Visuals are an important part of communicating your engineering or technical work. They must stand alone as information items, but they must also inform the larger piece of technical writing that surrounds them.

- In Introductions, visuals might include tables to help establish problems or lack in previous research attempts. Pictures might depict the problem, too.
- In Methods, for example, visuals can be used to represent apparatus or tools. Other visuals might be line drawings of experimental set-ups.
- In Results, visuals are used to efficiently represent findings and data.

Any use of visuals means that the information is being processed by the authors; thus, it is essential to create these with care and ethics. Any visualization provides a frame for the readers, and frames can affect objectivity. Every care must be taken to provide the cleanest, most efficient, most elegant visuals for your technical work.

Every effort must be made for legibility. If the numbers or the legend are too small to read, then the information is useless. Colors must be adequately differentiated. Teams may want to consider how their visuals might look in black and white and to readers that are color-blind.

Consequently, authors need to prepare readers to see and understand the visuals they use. The visuals are important, but so is the caption work that goes with them. In other words, all visuals must be integrated into the experience of the text.

5.1 Writing captions to support the visuals

Even the most technically savvy reader will look at a report's visuals first. It's human nature. Many times, the quality of those graphics will help that reader to determine whether or not to read the entire report. Thus, they need to be good.

There are only two categories of visuals: Figures and Tables.
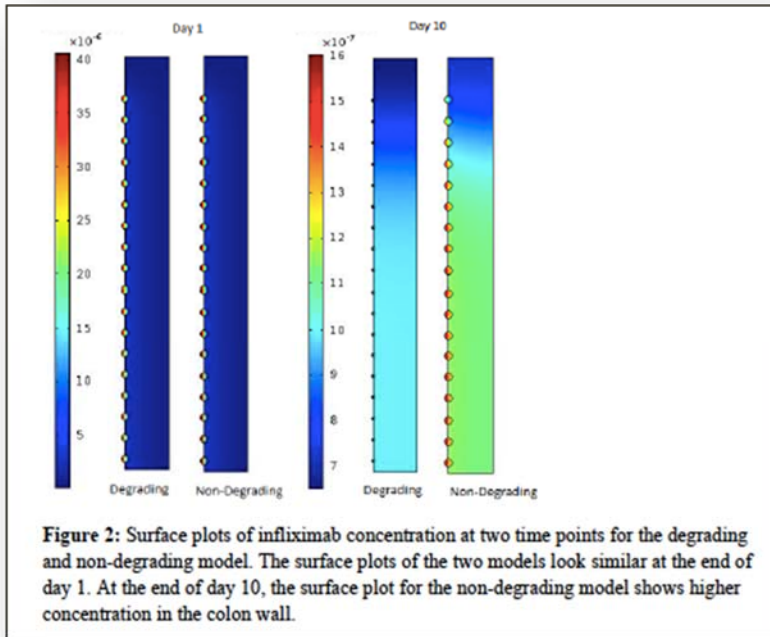
5.1.1 Figures

One way to assure quality is to include strong captions that explain the meaning of the elements represented. Typically, captions are below or to the side of the figure, and they use a different font than the rest of the report to set them apart visually.

At a bare minimum, each caption should have these three elements:
- Label (such as "Figure 1.0")
- Title (give a name to it, such as "Recalculated Regression Rates")
- Caption (several full sentences that guide the readers towards an accurate interpretation of the data; the caption may echo other explanatory text in the body of the report)

As well, you may need a Citation if your graphics is taken from an outside source. Below is a good example from Spring 2013 from the report "Modeling Concentration

Profiles of Infliximab in Colon Wall to Ensure Efficacy of Drug-Eluting Biodegradable Stent in the Management of Crohn's Disease" by Sean Dennin, Xing Li, and Danrui Yang.

Figure 2: Surface plots of infliximab concentration at two time points for the degrading and non-degrading model. The surface plots of the two models look similar at the end of day 1. At the end of day 10, the surface plot for the non-degrading model shows higher concentration in the colon wall.

5.1.2 Tables

By tradition, tables follow a slightly different set of conventions. Labels and Titles go at the top, while any interpretive information can be cast at the bottom. From the same spring 2013 report, here is a nice example:

Table 4: Input parameters used in the model

Input Parameter	Value/Expression	Unit	Source
Thickness of colon wall	1.6	mm	(Wiesner, 2002)
Radius of colon (from lumen center to colon wall)	30	mm	(Jones, 1969)
Radius of stent	0.135	mm	(Pavlides, 2011)
Spacing between two struts	0.50	mm	(Pavlides, 2011)
Length of stent	15	mm	(Boston Scientific)
Diffusivity of infliximab in colon (D_c)	4.292e-6	mm²/s	(Hicks, 2006)
Diffusivity of infliximab in stent (D_s)	7.725e-8	mm²/s	(Zhang, 2003)
Infliximab half-life ($t_{1/2}$)	756000	s	(FDA)
Degradation rate constant of infliximab in colon (k)	9.1686e-7	1/s	(FDA)
Stent degradation rate constant (cst) Day 0 – Day 6.2	1.17e-08	mm²/s	(Gopferich & Tessmar, 2002)
Stent degradation rate constant (cst) Day 6.2 – Day 8	6.91e-09	mm²/s	(Gopferich & Tessmar, 2002)
Stent degradation rate constant (cst) Day 8 – Day 10	4.11e-09	mm²/s	(Gopferich & Tessmar, 2002)
Initial concentration	5.00e-5	mg/mm³	(Merck)
Terminal volume fraction of stent	10%		N/A
Convergence Concentration Threshold	5%		N/A

This table contains all of the dimensions, physical and chemical properties, and rate constants utilized in this model. The length of a complete stent averages 60 mm. A length of ¼ of the entire stent (15 mm) was taken as the stent length in our model.

- When possible and appropriate, align decimal places for numbers/measurements.
- Capitalize consistently.

6.0 Creating Conclusions and Design Recommendations

As closing gestures, Conclusions and Recommendations can either be separate sections or combined. Authors are summarizing, considering, and assessing. The closing sections thoroughly vet the information.

6.1 Conclusions

Conclusions are most like introductions in that the function or purpose they serve is also to establish a shared understanding. However, whereas introductions establish a shared understanding of the context, as well as, the aims and goals or objectives of the report; conclusions establish a shared understanding of the experience of that report. In other words, in conclusions the authors summarize.

6.2 Recommendations

Further, design recommendations, in effect, return to the context for the report. Authors present the implications of the report in relation to the real-world problem or issue that was being addressed. In other words, in design recommendations, the authors consider and assess the relevance of the report to the problem or issue within that context. Again in past semesters, for example, students have made suggestions for further research and discussed possible realistic constraints in design. These restraints may be economic, environmental, ethical, health safety, social and/or political or involve sustainability and manufacturability.

6.3 Organizing the End

Below are important directives that your team should find helpful in determining what information to include in the Conclusions and Design Recommendations section:

- Interpret the results in the context of the questions that you set out to address in the Introduction.
- Make sure to include your design recommendations.
- Discuss realistic constraints. Again (as listed above) such realistic constraints in design make include economic, environmental, ethical, health safety, social and/or political or involve sustainability and manufacturability. Your team may find that the ones underlined are more relevant for your projects. Please discuss at least two of these constraints in relation to your project.

The moves that your writing should take are mirror images of items established earlier in the report:

1. Occupying that niche
2. Re-establishing a niche
3. Establishing an additional territory

7.0 Citing Sources

All outside research that has informed your project must be documented and cited properly using IEEE citation method. This includes textbooks, online (credible sources), journal articles, manuals, patents, technical reports, and so forth.

Anything taken from these sources is not worthy of your project: Wikipedia, HowStuffWorks, wikis, and other websites or sources than cannot be verified or that have not been reviewed by panels of technically trained experts.

8.0 Using a Unified Voice

We understand that most teams will divide the work and each person will take primary responsibility for certain sections. However, in the end, the entire report must sound unified. The communications instructors will advise teams on how to edit, proofread, revise, and rework text so that each section of the report sounds (in voice) like the one before.

In the end, the team's report should "read" as a unified, professional-level rendering of your research problem, outcomes, and interpretation. The written "voice" of the team **IS** its identity; you must ensure that your work sounds knowledgeable, credible, and professional.