UNDERGRADUATE

THESIS MANUAL

2006-2007

For use in
STS 401 - 402

Department of Science, Technology, and Society
School of Engineering and Applied Science
University of Virginia
Charlottesville, Virginia 22904-4744

PREFACE AND ACKNOWLEDGMENTS

This manual guides students and faculty through the Undergraduate Thesis Project. It is not exhaustive, so readers will also want to consult other resources (such as the University of Virginia Science and Engineering Library and handbooks of technical writing). The collection of undergraduate theses at the library furnishes examples of thesis documents and topics. These examples vary widely in quality (all you know is that a thesis received a grade of D- or above) and stylistic conventions, so do not assume that what you see is what you should do. Science, Technology, and Society advisors guide project design and documentation.

The production of this manual was a collaborative effort of the faculty and staff of the Department of Science, Technology, and Society of the School of Engineering and Applied Science at the University of Virginia. We acknowledge the advice and help of Luther Y. Gore, Professor Emeritus of Science, Technology, and Society. Professor Gore wrote much of the original text, edited the first four editions of the thesis manual, and established a framework that we continue to use. Rosanne Simeone, Patricia Click, Bryan Pfaffenberger, Deborah Johnson, and Edmund Russell have also provided suggestions and new material. Catherine Baritaud has helped with editing text and formatting. We also thank the staff of the Science and Engineering Library, especially Joan Ruelle and Susanna Boylston, Beth Blanton-Kent, Kathy Runkle, and technical faculty and students for their contributions. The manual's discussion of conducting a literature review is based in part on "How to Write a Literature Review in the Sciences" by Chris Skelly.

From time to time, new information related to the thesis project is posted on the Web page of the Department of Science, Technology, and Society: <http://www.sts.virginia.edu>

Questions and comments about the manual should be addressed to individual Science, Technology, and Society instructors or to Rosalyn Berne, the STS 401/402 thesis coordinator, at rwb@virginia.edu.

Rosalyn W. Berne, Editor
July 2006

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PART 1: OVERVIEW OF THE THESIS

BASIC QUESTIONS

What is the thesis?

The Undergraduate Thesis Project ("the thesis") is the major project you carry out in your fourth year. Aspects of this project include defining a topic, researching the literature, carrying out original research, writing up your results, and presenting your results orally. The thesis gives you the opportunity to:

- Pull together the material you have learned in your classes and use it to solve problems
- Produce scientific and technical knowledge
- Manage people and other resources
- Communicate with expert and non-expert audiences
- Deepen your understanding of social and ethical issues in engineering and science
- Distinguish yourself from graduates from other schools when applying to graduate school and employers

The Final Thesis Report, also referred to as "the thesis," is the written document produced at the end of the project.

Who is involved?

Thesis projects involve a range of people, some directly and some indirectly. They may include those who provide financial support to the project, collaborators, capstone clients, and ultimately, users of your ideas or products. However, the three primary people involved are:

- You
- Your Science, Technology and Society (STS) advisor, who is your instructor for STS 401 *and/or* 402.
- Your technical advisor

You are responsible for finding a technical advisor who is willing to serve in this capacity. This advisor guides you through the technical aspects of your project and evaluates your performance. Your STS advisor instructs you in the social and ethical contexts of engineering, guides you through thesis assignments, and grades those assignments. He/she takes your technical advisor's evaluation into account when assigning grades.

Part of your responsibility is to manage relationships with your advisors. This includes regular communication, such as written memos of due dates and procedures, the progress report, or personal visits to discuss your research.

Who can be a technical advisor?

The technical advisor must be one (and only one) member of the University of Virginia faculty. Graduate students, postdoctoral fellows, other faculty, and researchers at other institutions (academic, governmental, or industrial) may serve as expert advisers to students, but they may not serve in the capacity of the technical advisor.

Many students join capstone teams or laboratories, in which case the head of these endeavors usually serves as the technical advisor. Other students work individually with an advisor.

Most students choose advisors in their major. A number of students work with advisors from other SEAS departments. Some have advisors from other schools (including the College of Arts and Sciences) at UVA. (If you choose someone from outside SEAS, give that person a printed copy of this manual.) Standards of performance are equally high for students working on projects inside and outside of their major. <u>If you want to work with an advisor from outside your major, you must first obtain written permission from your department chair.</u>

When are assignments due?

Deadlines for thesis documents are the same for all students and appear in the general syllabi for STS 401-402. Instructors will not deviate from this schedule, with one exception: if students are submitting written assignments and making oral presentations on those assignments the same day, instructors may (but are not required) to allow that day's presenters short extensions on the written work.

Your topic statement, proposal, and thesis are considered completed *only* after both the STS advisor and the technical advisor have signed the cover pages of those documents. Passing the STS 401 or STS 402 courses requires that you obtain both of these approvals. **Obtaining and retaining copies of these signatures is your responsibility. You will need a copy of the signed title page of your proposal for your final binder at the end of the year.** (See Part 6 of this manual for contents of the final binder.)

How do I select a topic?

If you decide to use a Capstone project, other group or laboratory project as the focus of your thesis, then the topic will largely be determined for you. Otherwise, you select your own thesis topic, subject to approval from both your technical and STS advisors. The STS department Web site lists some projects for which faculty members are seeking students. Many topics come from a student's own interests and are found through student initiative. For example, most SEAS faculty departments have Web sites which describe individual faculty research projects. If you identify a faculty research project which is of interest to you, communicating with that person may open possibilities for you to work with them on their research.

To merit approval, the thesis topic must:

- **Meet a need** significant enough to justify investing resources to complete the project. You must identify the users and others affected by the results of your project.

- **Require engineering expertise and draw on published literature in the field.** You must possess or develop the necessary expertise. You must also draw on published work in the field and show how the project will advance it.

- **Be challenging and manageable within the time available**. The topic should be neither trivial nor so advanced as to be suitable for graduate work. The project should not duplicate work done by others, although all projects extend such work. It should offer the opportunity for an original contribution and go beyond the routine application of existing techniques.

- **Be one for which the resources — human, equipment, financial, and written — are available.** In choosing a technical advisor, you will need to determine what technical expertise, facilities, money, and information will be necessary and establish their availability.

- **Allow you the opportunity for some independent work**. Students who work on team projects must submit independently written reports and clearly distinguish their own contributions from those of others.

- **Be one you can communicate to a variety of audiences.** In the working world, engineers communicate with a variety of audiences, including engineers from their own discipline, engineers from other disciplines, and managers or members of the public who have no technical background. In the thesis project and STS 401 and 402, you will communicate with a similar variety of audiences. In written and oral presentations, you must make your project and findings accessible and convincing for both expert (your technical advisor) and non-expert audiences (your STS advisor and classmates). The results must be available to the public. (See below regarding proprietary and confidential information.)

- **Be one for which evaluation criteria can be established.** You and your advisors should agree on what will constitute success for the project at the start. One way is to ask, "How will I know if I have done a good, professional job on this project?" Part of this job is producing written reports. All concerned must agree upon any changes to the evaluation criteria.

In sum, a good thesis topic offers you the opportunity to make a **well-defined technical contribution** and to **use the project as a case study** in the interaction between technology and society and the relationship between personal and professional values. If you are concerned that your topic does not qualify, see your STS advisor immediately.

CATEGORIES OF TOPICS

These types of topics are acceptable for the thesis project:

- **Design a device, process, or system** (or a part of one of those). You will need to justify all elements of the design, proving theoretically and/or empirically the adequacy of the design. (Depending on the complexity and difficulty of the design, you may or may not implement and test it.) This category would include design of computer programs.

- **Implement and test** an untested or unsatisfactorily tested design.

- **Compare designs** of devices, processes, systems, or materials where questions of superiority have not been settled already or where there is reason to question a current practice.

- **Verify a theory** by empirical investigation, where such investigation has not already been carried out.

- **Derive a theoretical explanation** for unsatisfactorily explained phenomena, practice, or design.

- **Collect, organize, and present information** on a subject for a state-of-the-art report, where no comprehensive report has yet been written or, if written, has become outdated. You must verify, at the outset, that the work will not duplicate what has been done.

- **Produce a case history** of some event or circumstance to provide a comprehensive view that might be useful in establishing general principles for future similar events or circumstances.

- **Evaluate and interpret a current trend** to an extent not already done, taking into account and, where possible, resolving current conflicting interpretations.

For examples of recent thesis topics, visit the thesis collection in the Science and Engineering Library in Clark Hall.

PROPRIETARY AND CONFIDENTIAL INFORMATION

Because the thesis is an academic project, the results must be made public. Your advisors and your classmates will know a lot about your project. Your final report must go into the UVA library. For those working on proprietary or confidential projects:

- You need not disclose publicly everything you learn, but you must disclose enough to fulfill all requirements for the thesis project. It is acceptable to disguise the identity of individuals and organizations (for example, by referring to a company as “Company A”). It is also acceptable to report only some findings. In

evaluating your thesis, though, your advisors will assess only the public information (that is, you get no thesis credit for confidential work).

- You and the sponsor must agree on what may or may not be disclosed *before* committing to the project as a senior thesis. Every year, a few students are shocked to learn, shortly before the thesis due date, that a sponsor wants the results to be confidential. Do not let this happen to you.

CLASS PROJECTS AND RESEARCH OUTSIDE UVA

Thesis topics may relate to work the student has done in a previous course or on a job, but, in such cases, the student must demonstrate that he or she has made significant contributions to the project outcomes. All proposal and thesis-related documents and assignments must still be prepared and presented by the student, and the project itself must meet all of the requirements outlined above. In most cases, it is best to treat previous work as the starting point for the thesis project and to refine or expand on the work already done. If possible, you should familiarize yourself with the requirements for an appropriate thesis topic and with the documents they will produce throughout the project **before** they begin a course or work assignment that might eventually become the topic for a thesis.

PROFESSIONAL AND ETHICAL RESPONSIBILITY

In general terms, it is your responsibility to:

- Be truthful in everything you say and write. You do this by accurately representing the views of others, reporting methods and findings fully, interpreting data accurately, and explicitly addressing weaknesses or flaws as well as strengths in your work. The greatest temptation here is probably to present your work and findings only positively.

- Obtain and use information honestly. You do this by documenting all information and ideas from others (see section on documentation below), taking credit only for work that you do, and giving credit to others for the work they do. The greatest temptations here are probably to plagiarize and to take credit for work done by others.

- Obtain and use resources for their intended purpose. You do this by explaining the purpose of funding, equipment, advice, or other resources when you ask permission to use them, using only resources to which you are entitled or receive permission, and using those resources as intended. The greatest temptation here is probably to take equipment or spend money in unjustifiable ways.

- Follow UVA protocols for any research involving human subjects (see <http://www.healthsystem.virginia.edu/internet/hic> web site).

- Clarify with collaborators, at the outset, who owns any work products (such as data or designs), and how those products may be used.

Of course, as a University student, you must always adhere to the honor guidelines:

HONOR GUIDELINES FOR PAPERS IN THE DEPARTMENT OF SCIENCE, TECHNOLOGY, AND SOCIETY COURSES

The Honor Code Pledge. Unless indicated otherwise by the instructor, the Honor Code Pledge must be written out *in full* and signed *in full* by the student in every assignment to be graded. The pledge is as follows:

On my honor as a University student, on this assignment I have neither given nor received unauthorized aid as defined by the Honor Guidelines for papers in Science, Technology, and Society courses.*

Signed: _____

* If you have received assistance from the University Writing Center, this must be acknowledged in the pledge.

If you have someone else type your paper, you must instruct that person to copy the manuscript **exactly** as given, **so that the text of the paper is entirely your own.** You may not accept any editorial assistance from that person regarding spelling, grammar, organization, word choice, or punctuation.

What Aid Is Permitted. On any assignment to be handed in, the student is encouraged to make use of dictionaries, thesauruses, composition handbooks, and other reference works on writing intended to help him or her write well. Programs in word processing that check spelling, diction, or grammar, or other stylistic matters are permitted.

What Aid is Not Permitted. Editing, critiquing, or proofreading by others, whether voluntary or paid, is not permitted, except that certain assignments, which will be noted by the instructor, are designed to include peer critique or editing.

The University Honor Code. Students are expected to study, to understand, and to abide by the University Honor Code in matters relating to quotation and paraphrase of another author's work. Clarification of any of these matters should be sought, when needed, before assignments involving them are handed in. The STS department faculty endorses the University Honor Code and cooperates with the Honor Committee in enforcing it.

Special Exceptions of These Guidelines. Students with physiological disabilities such as dyslexia or poor eyesight may be granted, upon application to the instructor, the right to have assignments that they have prepared proofread by someone else. The proofreader's assistance must be acknowledged in the pledge. Even in circumstances where no special disability exists, students are often encouraged and always permitted to seek assistance from the University Writing Center. Again, assistance from the Writing Center should be acknowledged in the pledge.

Some Important Distinctions

Critique means to read and evaluate someone else's work without suggesting or making specific changes in the work.

Edit means to make specific changes to a work, either in mechanics, such as spelling, punctuation, syntax, or word choice, or in organization or content of an assignment.

Proofread means to correct errors in mechanics such as spelling or punctuation or to rectify omissions or unintentionally included materials that can occur when a manuscript is transcribed by typing or word processing. Anyone other than the student who types the assignment must reproduce the assignment exactly as given to him or her. They are permitted to proofread the completed document to ensure that they have transcribed it exactly as received from the student.

PART 2: WRITING, FORMATTING AND PRESENTING

LAYOUT

For **title pages**, follow the models in this manual.

- Follow punctuation exactly. If the model shows caps and lower case (Instrumentation), do not change the pattern (INSTRUMENTATION would be incorrect). Do not underline or put quotation marks around the title of your own document.
- Type out the names of your advisors where it says "type name" (Mary Smith, not Type Name).
- Use no honorifics (Dr., Professor, Mr., Ms.).
- Write out in full and sign in full the Honor Code Pledge on the title or cover page of all documents.
- Follow the correct model for each assignment. For example, do not use the thesis proposal title page for the thesis final report.

For **section headings:**

- Be consistent in format throughout the document.
- Use headings within sections or chapters sparingly or not at all. Never use a section heading for every paragraph.

For **all pages**:

- Leave a 1.5" left margin and a 1" margin on all other sides of the page.
- Except for the title page, double space **all** text. **The table of contents, abstract, and bibliography/works cited are all double spaced.**
- Double space between paragraphs; just as you do within paragraphs. Hit the return key once at the end of a paragraph, not twice.
- Indent the first line of each paragraph.
- Number all pages (except the title page). Continue numbering through appendices (do not number them separately).
- Use 12-point type.
- Use a roman (serif) typeface, not gothic (sans serif). Serifs are the little horizontal lines on the tops and bottoms of letters that guide your eyes horizontally across the page. Times, Times New Roman, and Palatino are good choices of roman typefaces. This sentence is in a sans serif typeface. Using san serif type in text slows the reader by about 20% because it is harder to keep track of which line one is on. You may use a gothic typeface in section headings but not text.
- Turn in error-free copy. If you find a mistake, correct it and print a fresh page.

WRITING STYLE

Use clear, concise prose. Writing handbooks provide good advice. Use the guide to style required or recommended by your STS advisor. (This is usually listed on the course syllabus.) Do not worry about style or grammar in early drafts; focus on getting ideas onto paper. Then revise, revise, revise. The key to good writing is rewriting. Helpful hints:

- Omit needless words. "*Due to the fact that*" should be "*because*"; "take into consideration" should be "*consider.*"
- Write with nouns and verbs. Avoid adjectives and adverbs except when they do important work in the sentence.
- Use active voice, not passive. Active voice is direct, precise, and clear. Passive voice sets two traps: (1) it enables you to write grammatically correct sentences without actors, which leads to fuzziness, and (2) it is wordier than active voice. Hint: passive voice always requires a form of "to be." (Not all uses of "to be," though, are passive voice.)
- Use shorter versions of synonyms. Never utilize "utilize"; always use "use."
- Describe past events (such as research) in past tense.
- Keep the focus on the work, not on you. Minimize first person.
- Start paragraphs with topic sentences.
- Use gender-neutral language except when gender matters.
- Write for your readers, not for yourself. Present information at a pace readers can follow.
- Avoid jargon, including acronyms. All your work must reach non-expert as well as expert audiences. Each jargon word or acronym asks your non-expert reader to learn a "foreign" word, which interferes with your message.
- Use parallel construction. Example:

  The test involves two phases:

  1. Putting the sample on the viewing stage.
  2. Raise the stage until it sits just below the probe.

  should be

  The test involves two phases:

  1. Putting the sample on the viewing stage.
  2. Raising the stage until it sits just below the probe.

- Use the spelling, grammar, and style checker in your word processor. Turn on all the features before running the check. You still must use your judgment. Checkers do not find all errors, and they flag some "errors" that are not. But their advice is usually correct.

To start your words and ideas flowing, you may want to employ one of the Invention Strategies described in Appendix A.

LITERATURE REVIEWS

The Role of Published Literature in Your Project

From the time you first begin to define your topic through the time you complete the final thesis, you will need to **draw on a wide range of published literature.** Conducting a professional review of literature is essential to establishing the justification and approach for your project and for acquiring the expertise you will need to undertake it successfully. (See Appendix B for details on writing a literature review, and for sample literature reviews.)

The most easily identifiable outcome of your literature search will be the review of literature section that will appear in your proposal, but published literature will play an important role in all stages of your project**.** Think of the literature review not as something you do one time but rather as **an ongoing process** in which you gather the expertise and information you will need **to shape, justify, execute, and document** your project.

As you conduct your literature search, you might imagine a room occupied by all of the experts in the fields of research that support your topic. These experts are sitting in a circle, discussing past, current, and future work. You hope to enter that room, join the circle, and participate intelligently in that **critical conversation.**

To do so successfully—i.e., to be taken seriously as a colleague—you need to first do your homework and be able to demonstrate that you are familiar with the critical conversation. Once you have done your homework, you will at least be in a position to ask intelligent questions. By the time you have completed your own research, you will also be able to contribute to that conversation.

Throughout your project, you will be encouraged to think critically about and to reflect on the processes of problem definition, engineering design, and project management. You will also deepen your understanding of (a) the impact of engineering solutions in a global and social context and use that understanding in the formulation of engineering problems, solutions, and designs and (b) professional and ethical responsibilities as they apply to your particular project. A broad understanding of both the technical and non-technical contexts of your project will be essential for achieving these goals. Developing this broad understanding will be one of the major goals of your review of literature.

Three Important Keys to Writing a Literature Review

I. Answer the following questions:

- What is **known** and how will you **use that knowledge** in your work?
- On what relevant issues is there a **consensus**?

- On what issues is there significant **debate**? What are the **various positions**?
- Who are the most **prominent names** in the field? What have they said or done that is significant?
- What is the **chronology** of the development of knowledge that affects the question you are asking?
- What are the **gaps** in knowledge? Which gaps have been identified by other researchers? Which gaps are apparent from your review, and how do you intend to fill them?
- What appear to be the most **fruitful directions for future research**? Which directions have been indicated by other research? Which directions do you see as a result of your literature review? How does your project continue in, or diverge from these directions?
- What non-technical factors (social, ethical, environmental, etc.) influence the problem you are addressing or its solution?
- What aspects of the problem can be adequately addressed with technical solutions? What aspects must be addressed by other means?

You will need the answers to these questions before you can write a professional proposal. As you become more expert, you will identify additional questions that the literature can assist you in answering.

II. Aim to identify a variety of quality source materials to fulfill a range of functions:

For example, you will need sources to support your discussion of the current state of knowledge, including sources that provide a general overview of developments in the field. You will also need references to specific aspects of the project, including (1) historical background, (2) theory, (3) experimental or design methodology, (4) applications, and (5) consequences. The "Selected Engineering and Applied Science Reference Works" in Appendix B describes the different types of sources and how to access them.

Since projects vary so much, it is difficult to make hard and fast rules about **how many sources** you should have. As a general guideline, however, you should:

- Aim for at least 15 sources for the proposal (stronger proposals often have more)
- Avoid over-reliance on sources that are available only via the Web, and
- Provide justification if either of these first two requirements cannot be met

As your project evolves and your knowledge of the subject expands, you should add new sources to your bibliography.

III. Aim for completeness, consistency, and accuracy in your citation of sources:

Cite your sources using a consistent style of documentation appropriate to your field of research. (See "Documenting Sources" for specific guidelines on how to proceed.) From the very beginning of your work, be accurate and organized in recording details and ideas from your sources.

While there is no single ideal strategy, your approach to the review of literature should respond to the particularities of your topic. The questions addressed below, however, generally apply to most projects:

DOCUMENTING SOURCES

Why should I document sources?

You document sources to add credibility to your work, give credit to others for their contributions, and let your readers know the sources of information in case they wish to do further reading on the subject. Here, we use "documentation," "citation," and "reference" to mean the same thing. We also use "system," "method," and "style" interchangeably.

You must credit the original sources of all quoted material, all illustrations (graphs, figures, etc.), and all ideas that are not your own. Failure to do any of these is plagiarism, a form of stealing (improperly taking something from another person or organization) and lying (claiming the work of others as your own) that violates two tenets of the University of Virginia Honor Code. (See the "Professional and Ethical Responsibility" section for more information.)

How do I document sources?

The spirit of any citation system is that anyone else should be able to retrace your steps and find the same document. Your citations must be complete and consistent.

In engineering, most editors prefer an in-text reference system. Parenthetical or bracketed citations in the text, which refer to a list of works cited at the end of the document, indicate sources of all quotations, ideas, and information. Most projects should use an in-text system.

In a few projects, it may be better to use a standard footnoting/end noting system (more common in the humanities). In this case, use the Chicago endnote/footnote system (described in writing handbooks). Superscript numbers (such as[1]), refer to footnotes at the bottom of the page or to a list of endnotes at the end of a chapter or the entire paper.

Ask your advisors which method you should use. No matter what method you employ, use one system, and only one system, throughout a document.

How do I use in-text reference systems?

Science and engineering publications use two main in-text systems:

- **Author-Date notation.** This system puts the author of a work and the date of publication in parentheses like this (Smith 2004). Cite a specific page this way (Smith 2004: 323). References appear in alphabetical order (by author's last name) in the works cited section at the end of the paper. This system has

variations. Most technical writing handbooks describe the APA system. (APA stands for American Psychological Association.)

- **Numerical notation.** Here, numerals appear in brackets or parentheses like this [1]. The first citation is numbered [1], the second [2], and so on. If you refer to the first source again later in the paper, you insert [1] again. Cite a specific page like this [1: 323]. References appear in the works cited list in numerical order (the order in which they appear in the text). This system too has variations. Technical writing handbooks often describe the IEEE (Institute of Electrical and Electronic Engineers) system.

Refer to a technical writing handbook for details on using these systems. What follows is a discussion of common confusions or errors, not a full explanation of the systems.

How do I punctuate if I use an in-text reference system?

An in-text citation usually appears at the end of a sentence. Placement of the period often creates confusion, but the rule is simple: THE CITATION IS THE LAST ITEM BEFORE THE PERIOD. Other words or punctuation marks, such as quotation marks, go before the citation.

Spacing also can create confusion. Here too the rule is simple: INSERT ONE SPACE BEFORE THE PARENTHESES OR BRACKETS.

WRONG	**RIGHT**
PERIOD BEFORE THE CITATION: According to H. Uhlig and R. Revie, the annual production of stainless steels in this country is over a million tons. (3:300) This quantity…	According to H. Uhlig and R. Revie, the annual production of stainless steels in this country is over a million tons (3:300). This quantity…
TWO PERIODS IN ONE SENTENCE: According to H. Uhlig and R. Revie, the annual production of stainless steels in this country is over a million tons. (3:300). This quantity…	According to H. Uhlig and R. Revie, the annual production of stainless steels in this country is over a million tons (3:300). This quantity…
NO SPACE BEFORE PARENTHESES OR BRACKETS: According to H. Uhlig and R. Revie, the annual production of stainless steels in this country is over a million tons(3:300).	According to H. Uhlig and R. Revie, the annual production of stainless steels in this country is over a million tons (3:300).

QUOTATION MARKS AFTER THE CITATION: According to H. Uhlig and R. Revie, "in recent years, annual production in the United States of all types of stainless steels, including heat-resistant compositions, has reached over one million tons (3:300)".	According to H. Uhlig and R. Revie, "in recent years, annual production in the United States of all types of stainless steels, including heat-resistant compositions, has reached over one million tons" (3:300).
NO SPACE BEFORE PARENTHESES OR BRACKETS: According to H. Uhlig and R. Revie, "in recent years, annual production in the United States of all types of stainless steels, including heat-resistant compositions, has reached over one million tons"(3:300).	According to H. Uhlig and R. Revie, "in recent years, annual production in the United States of all types of stainless steels, including heat-resistant compositions, has reached over one million tons" (3:300).

If the material is **a direct quotation of four lines or fewer**, incorporate the quotation and its source into your text:

> **Example**: According to H. Uhlig and R. Revie, "In recent years, annual production in the United States of all types of stainless steels, including heat-resistant compositions, has reached over one million tons" (3:300).

If the material is **a direct quotation of more than four lines**, shorten it. Readers skip indented quotations, and relying so heavily on the words of others suggests that you have not mastered the material. If the quotation is indispensable (a rare event), indent and single-space the quoted material and eliminate the quotation marks. Insert the parenthetical citation between the last word and the period:

> **Example**: According to H. Uhlig and R. Revie,
>
> > in recent years, annual production in the United States of all types of stainless steels, including heat-resistant compositions, has reached over one million tons. These figures represent a marked departure from the trends established earlier in the this century (3:300).

If the material is **an illustration**, place the parenthetical citation after the caption.

> **Example:** Figure 1. Pitting Potentials for Cr-Al Alloys in NaCl at 13° C. This graph demonstrates that Cr-Al alloys experience significant pitting at temperatures of 13° C (6:78).

Where should I cite references?

- Cite a quotation **immediately** after you use it.
- Cite **ideas** (things you have paraphrased) **immediately** after you use them.
- Cite **illustrations** at the end of the caption, as noted above.
- If information from a source extends over more than one paragraph, cite the source in each paragraph.

How do I format the individual entries in my bibliography or works cited?

See a writing handbook for guidance on formatting sources in these sections. Use the same system (APA, IEEE, or Chicago) in the text and in the bibliography/works cited; never use one in the text and another in the bibliography/works cited.

If you are using the APA system and have two publications from the same author in the same year, add small letter "a" to the year of the first and small letter "b" to the year of the second. Then use the modified years in the text (Smith 2004a: 323) and in the bibliography.

How do I format bibliographic entries for online sources?

In general, you follow the format for print entries (author, title, and publication details) and add the details that are particular to online sources. These include (1) the date of access (e.g., 10 August 1999), and (2) the complete electronic address (URL).

When the online source also exists as a printed source, following this format is fairly straightforward. For sources that exist only online, it becomes a little trickier, largely because the traditional categories such as "author" and "publisher" often seem not to fit well. A good source for online citation information is OWL at Purdue: <http://owl.english.purdue.edu/handouts/research/r_docelectric.html>.

Whether they appear in the text itself or in a bibliographic entry, all Web addresses should be enclosed within angle brackets < >, as they are in the paragraph immediately preceding this one.

The acceptable standard for citing sources is evolving, but the same principles of completeness and consistency apply. If you have trouble obtaining enough detail about an online source to create a reasonably complete bibliographic citation, you probably also don't have enough information to assess the source's reliability.

Do I need a Bibliography if I have a list of Works Cited?

Usually a Bibliography includes more works than those that you have cited in the paper. For example, you might include things in the Bibliography that you used as background

reading, but did not cite in the text — things that another reader might want to read about the subject.

If you do not use any sources other than those on the Works Cited list, you may eliminate a separate Bibliography.

GRAPHICS

It is essential to include diagrams, illustrations, tables, and charts in the proposal and thesis. Graphic materials may be used to document your apparatus or design as well as to present your quantitative results. Visual materials are an effective means to convey to your reader the essence of your work. To achieve this effect, however, the graphics must be coherently integrated into your text. Most readers will probably comprehend little more than what you have explained or interpreted in the text. Therefore, be sure to discuss each figure or table in enough detail that the reader can clearly understand it. (See Appendix G: "Preparing Graphics.")

PART 3: STS 401

TOPIC STATEMENT

You begin the process of deciding upon and shaping your topic with a brief document called a statement of topic. Your instructor may ask you to use the topic statement form (see Part 4) or write a short (one page or less) discussion of the topic. Although the document itself is very brief, you will need to do at least a little preliminary research before you write it.

The statement of topic should answer four basic questions:

1. **What** do you plan to do?
2. **Why** is it worth doing?
3. **How** do you plan to do it?
4. What is **the key question** your work will be designed to answer?

As another way of focusing your topic and defining your objective, indicate a working title for your project.

If you are unsure of a topic right now, use this assignment as a way to brainstorm. Write a statement of topic on several ideas that have come to you. Evaluate each topic in light of the requirements for an appropriate topic as well as your own interests. (See "How Do I Select a Topic," pg. 2.)

You may hand in more than one statement of topic. In any case, both you and your Science, Technology, and Society advisor will use this assignment as a way of homing in on your preferred topic. This assignment is required but will not be graded.

PRE-PROPOSAL

The Function of the Thesis Project Pre-Proposal

Proposals are carefully prepared documents, often calling for considerable research and planning. Because of the work that goes into a proposal, it is usually advisable to submit a pre-proposal as a way of determining whether a project would be eligible for consideration. In effect, the writer of the proposal wants to know if his or her ideas are "in the ball park." If the answer is "no," there is no point in going to the expense of time, effort, and money that a full-scale proposal might entail. You will be using the pre-proposal to determine whether the project meets the general requirements before you invest the time necessary to write a full proposal.

Another important purpose of the pre-proposal is to encourage you in the process of shaping and expressing ideas. Another is to call on the experience of your advisors to

determine whether the project generally meets the requirements for an acceptable thesis. Your advisors will be especially concerned to determine whether the size and scope of the project are reasonable and whether the information, materials and equipment, and funding (if necessary) are available to complete the project. They are also a critical source of suggestions for improvement; an important aid to writing a successful proposal.

Suggestions for Planning the Pre-Proposal

As you develop your conception of the project and write the pre-proposal, ask yourself the following questions, which embody the criteria for an appropriate project developed in, "How do I Select a Topic."

* Does the project meet a real need?

* Does it draw on engineering expertise and relate to the published literature in the field?

* Is it both adequately challenging and manageable?

* Are the necessary resources available and accessible?

* Does the project offer the opportunity for independent work and for demonstrating the ability to manage a project professionally?

* Can you communicate the project successfully to a variety of audiences?

* Will you be comfortable and interested in using the project to explore the interaction of technology and culture and the relationship betwen personal and professional values?

Remember that one way to focus your topic and more clearly define your objective is to state your proposed topic in the form of a question. The information to be presented in your thesis is the answer to that question.

Suggestions for Writing an Effective Pre-Proposal

The pre-proposal will present the topic under consideration, including the context in which it answers a need. You should begin by indicating a working title for your project. In the paper you should do the following:

1. Introduce your proposed topic briefly in an opening paragraph. Indicate your objective (**What?**) and motivation (**Why?**).

2. Indicate your approach (**How?**). Discuss the work that you will need to do to accomplish your goals, as well as the resources that will be required. This part of your paper should include:

a. a discussion of the engineering work required to accomplish the technical tasks central to the project, with emphasis on the most difficult task;

b. a discussion of your bibliographical research strategy (how you plan to find related work already existing in the field);

c. a discussion of your materials, equipment, and funding;

d. a discussion of your own background, knowledge, or experience that makes you particularly suited to complete the project; and

e. a discussion of the relationship you propose to establish with your STS and technical advisors. (Please identify the technical advisor in the pre-proposal.)

3. Forecast your response to upcoming thesis-related assignments in STS 401 and STS 402, especially the review of literature and the analysis of social and ethical contexts of the project. You must consider the background of research and accomplishments into which your work will fit — the theoretical underpinnings of your work — and the social and cultural implications of your work.

When you are writing your pre-proposal, remember that it should be persuasive, convincing the reader that the project is a good idea and that you are the right person to handle it.

You should submit one copy of the pre-proposal to your STS advisor and one copy to your technical advisor. Include a title page that follows the format presented on the next page of this manual. Print out and complete the pre-proposal checklist, which follows the model title page.

UNDERGRADUATE THESIS PROJECT PRE-PROPOSAL
School of Engineering and Applied Science
University of Virginia

Energy Conservation Measures

for Dormitories at the University of Virginia:

Lighting Audit and a Plan for Retrofits

Submitted by

Brad Grimes

Mechanical Engineering

Indicate group here if applicable

STS 401

Section 7 (10 a.m.)

September 20, 1999

Science, Technology, and Society Advisor: Kathryn A. Neeley

Technical Advisor: P. Paxton Marshall

On my honor as a University student, on this assignment I have neither given nor received unauthorized aid as defined by the Honor Guidelines for Papers in Science, Technology, and Society Courses.

Signed _____

CHECKLIST FOR THE PRE-PROPOSAL

Name:_____

Title Page:

_____ project title

_____ student's name

_____ student's major

_____ group/partnership (if applicable)

_____ section number and time

_____ date

_____ Science, Technology, and Society advisor's name

_____ technical advisor's name

_____ pledge with signature

Format/Quantitative Aspects:

_____ page numbers

_____ stapled

_____ references cited in text

_____ minimum of 3 references in bibliography

_____ correct margins and spacing (see section above)

_____ Maximum three pages (not counting title page)

Qualitative Aspects:

accessible opening

excellent poor

what?

excellent poor

why?

excellent poor

how?

excellent poor

THE PROPOSAL

The proposal plays an important role in engineering and applied science practice. It is an extended statement of some piece of research or other engineering work to be undertaken, along with justification for undertaking it, estimates of costs, details on personnel who will be involved, and other information related to the task of "selling" a particular idea to those who fund it. It is reviewed by management, who decide whether the project should be carried out and, if so, how much will be allocated for it and what changes must be made to the proposed work.

Proposals are especially important in projects funded by federal and state governments or by private funding agencies such as the Ford Foundation. These groups often make funds available for certain types of projects and send out requests for proposals to individuals and groups who might be interested in specific areas of research.

As a persuasive document, your thesis project proposal should convince your advisors that:

* ***You have defined a project of appropriate scope***

  The topic explored in the pre-proposal has been narrowed or developed into a thesis project that is both ambitious enough to qualify as original research and, at the same time, feasible within the given time frame (the five-month period between Thanksgiving and Spring Break, when most of the project will be undertaken). The project should address a genuine need in the field — a need for specific research to answer a well-focused problem, or for work to develop or assess a promising new design alternative. The project should employ only those resources that are readily available at the University or through reliable external sources.

* ***You have developed a sound and promising approach to the project***

  In the proposal, you should show that you grasp the nature of the research or design problem that you will investigate and that you have laid out a series of specific steps that will permit you to answer the research question or achieve and evaluate the design. In framing your approach, you should demonstrate your awareness of what constitutes good practice in your field by reviewing your approach with your technical advisor.

* ***You possess sufficient knowledge, skills, and resources to undertake the project successfully***

  You must demonstrate this background in your proposal by citing relevant courses and work experience, together with an explanation of how these courses and experiences have equipped you with the specific skills, knowledge, and heuristics you need to accomplish this project.

Ground Rules

The proposal should reflect a substantial amount of thinking, planning, and research. In the pre-proposal you simply suggest a topic and hint at your research strategy. In the proposal, by contrast, you are expected to fully define your research problem and your plan of attack, based on discussions with your advisors as well as a **careful review of relevant literature** from the appropriate technical fields. This literature discussion should build credibility for the project and your ability to undertake it.

The proposal is not only a persuasive document, but it is also a contract, which obligates you to undertake the work you specify. In the event of any change in the work as it proceeds, you must notify the two advisors in writing and seek approval for the change. The final report should reflect completion of the originally proposed work, except for any approved changes.

You must remain in close contact with **both advisors** about the progress of the project. **You should plan to confer with the technical advisor at least once per month, and more often during the periods when you are conducting experiments, collecting and analyzing data, or completing your design.** You must specify in the proposal how often you plan to meet with your technical advisor. Please remember that one of the purposes of the thesis project is to assess your ability to function as a professional. Problems arise in every engineering project, and it is unprofessional to disguise them or pretend that they do not exist. Your advisors will assess how maturely and competently you deal with them.

You must make three copies of your proposal: one for each of your advisors and one for your files. In the copy you submit to the technical advisor, attach the **proposal approval form**, a sample of which is included in this section. Assuming your technical advisor approves the project; he or she will sign the form and return it to the Science, Technology, and Society advisor via messenger mail. If the technical advisor requires changes or alterations to the proposal, you must notify your Science, Technology, and Society advisor and submit a revised proposal. Both advisors should sign the title page of your proposal once it is approved.

Policy on the Length of the Proposal

As a general guideline, items I-V should be no longer than 15 double spaced pages of text. Illustrations do not count as part of the 15 pages. Students must seek explicit permission from their STS advisor to submit a proposal longer than 15 pages.

PARTS OF THE PROPOSAL

All listed parts are required. Parts may be organized differently as long as all required functions are fulfilled and as long as your advisors concur with your plan of organization.

Front Matter

-Proposal Approval Form (inserted in technical advisor's copy)
-Title Page (signed by both advisors when the proposal is approved)
-Table of Contents, with page numbers
-Abstract (one page maximum)

Body of Proposal

I. Rationale and Objectives

II. Preliminary Analysis of Social Context and Ethical Implications

III. Review of Technical Literature (may be incorporated into Rationale and Objectives)

IV. Statement of Project Activities
- A. Activities
- B. Schedule
- C. Personnel
- D. Resources

V. Expected Outcomes

Bibliography

Required Appendices
- E. Budget and Equipment Checklist
- F. Biographical Sketch of Student
- G. Preliminary Outline of Thesis

CONTENT OF INDIVIDUAL SECTIONS OF THE PROPOSAL

Abstract

This section describes your project succinctly by stating the controlling question or hypothesis, research or design objectives, proposed methodology and anticipated results. The abstract should be treated as a self-contained document that could be published separately from the proposal and that could be used by the technical advisor to assess your proposal without reading the entire document.

I. Rationale and Objectives

In this section, you establish the significance of your research by discussing why your project is worth undertaking and potential applications, impacts, and benefits of your work. Through this discussion you demonstrate that you fully grasp the nature of the research or design problem you propose to investigate. Your argument should provide an historical context for the problem, explain how your project will solve it, and persuade

the reader that the investment of your time and effort is justified in terms of its contribution to society.

Rationale:

* Clearly and concisely describe what you are trying to prove or attempting to design through your research.

* Define key terms and theoretical concepts needed to understand your research.

* Illustrate key concepts or processes discussed in the text. If you copy an illustration or graph from a published source, you must credit the source. For more information, consult the section on Graphic Materials. In any case, the statement should serve as a source of information for a manager or planner responsible for your project and similar projects.

Objectives:

* Briefly state the specific objectives of your project. These may be expressed in the form of a list.

II. Preliminary Analysis of Social Context and Ethical Implications

This section of the proposal requires you to think about the broader social context and ethical implications of your project. In this section of the proposal, you should justify your project in terms of values that lie outside the exercise of technical knowledge and skill. You should emphasize the cultural values, beliefs, and practices to which your project relates. In the context of the proposal, this section helps make the case for your project by being more explicit about the larger purposes the project serves.

What should be included in the discussion of social and ethical contents of the project?

There are a variety of ways to think about the social and ethical issues contents of your project. First, and perhaps foremost, the topic of your thesis is most likely to have captured your interest and the interest of other researchers in your field because it responds to something that is happening in society – a problem that needs a solution. Thus, part of the discussion of the social context and ethical issues of your thesis topic is a matter of articulating why your project is important; what it will help people to do or know; and what problem it addresses or what needs/desires it fulfills.

Another way to think about and tease out the social context and ethical issues related to your project is to think about the consequences of the new knowledge or new product or new system that your project aims to develop. How is your project or the endeavor that it is part of likely to change the world? Will it lead to changes in the way people behave? To the environment? To the way people are organized? Will it increase or decrease risks to individuals and groups? Will it resonate or conflict with cultural or moral values?

It is often helpful to think in terms of stakeholders. What individuals or groups of individuals will your project affect? These might be consumers or managers or businesses or governments. Depending on the project, different groups may be affected differently so you should ask; will my project affect men and women differently? Different minority groups differently? Will it affect Americans or citizens of other countries differently? Citizens of Virginia or of other states? Employers or employees? Teachers or students? And so on.

The project should be viewed not only from the perspective of experts but also from that of users, and among users, you should consider those affected directly vs. indirectly; those who are voluntarily vs. involuntarily involved; intended beneficiaries vs. inadvertently affected; and those who have a voice in decision making vs. those who do not. Consider how the burdens and benefits of the new technology will be distributed and consider the merit of the proposed project in relation to other efforts toward which resources could be allocated. You might ask yourself whether and how your project connects to ongoing or recurrent ethical issues such as social justice, equality, risk, quality of life, health, privacy, and so on.

Will your research in itself involve any ethical issues? For example, will you be studying human beings? If so, do you have their permission to be studied? Will the research violate their privacy? Will you be dealing with information that is proprietary or classified? If so, this would raise ethical issues with regard to how you use and present the information. Or perhaps something you will be developing will have to be tested on animals first. This raises issues of humane treatment of animals.

Don't be surprised if you need to do research and reading for help in thinking about the social context and ethical implications of your project. As with other parts of the proposal, you should cite sources to indicate where you got the information and perspectives incorporated in your analysis.

Other Suggestions

1. Prepare a list of the full range of motivations and possible interactions of your project inside of society. To get this list, you need to use your imagination — your divergent thinking processes. You will probably also need to do some research about the larger contexts of your project. Consider what you've learned through your search of the technical literature and from analogous historical and literary examples. Consider how the problem is framed in technical literature. How do engineers and scientists see the social context of your topic? You may wish to get two or three friends to join you, to help you get beyond emotional blocks that hide impacts that seem threatening and to discover motivations that often go unarticulated. Get as full a list as you can, in writing. Use free association, brainstorming, or other techniques.

2. Think visually. You may find it useful to think of your project's as part of a set of circles fitting inside of one another, each representing a layer of context or issues. Examine your list to determine which impacts are direct, which follow

from others, which are independent of all the rest, and which interact with others. You may find it useful to develop a flow chart on the largest piece of paper you have available, showing the cascade of impacts from your work. This cascade should follow through to at least two, more likely to three, successive levels of effects. Be sure to show interactions. You may wish to note whether these tend to cancel or to augment effects. In addition, be sure to consider the factors that are prerequisites for successful implementation of the project, i.e., the things that will have to fall into place the work can be fruitful. It is rare that the simple completion of an individual thesis is adequate to achieve its intended objective(s).

3. Review your lists to determine who is likely to feel the results of your work, and/or those who make apparent its need. You should then project the type of response those persons or groups may have, included those that are intended, and those that are unintended. You should also identify situations where these persons may be affected before they discover your work as the cause.

4. Develop your discussion and analysis in a way that follows the logic inherent in your project and its potential for effecting or engaging humans or systems. For example, you might organize your discussion according to those who would directly or indirectly have interest in project such as researchers working in the field, corporations, and consumers. In any case, you should think carefully about how to organize your material and integrate it effectively into your proposal.

III. Review of Technical Literature

The literature search you conduct supports your argument and situates your project within your professional field. It should also demonstrate that you have thoroughly reviewed the literature and gained a good grasp of it. For some projects, it may be more appropriate to integrate the literature review with the Rationale and Objectives rather than making it a separate section of the proposal. (Sample literature reviews appear in Appendix B of this manual.)

Aim for a well-balanced bibliography containing 10-15 sources. If the number of sources is fewer than this, or if some aspect of the list (such as a preponderance of sources that are available only via the Web) might seem questionable, the review of literature section is the place to explain any apparent flaws and to make the case that your sources are adequate to the task at hand.

IV. Statement of Project Activities

In this section, you specify what you intend to do, how you intend to do it, and how you will know whether you have succeeded. In other words, you develop and explain the project objectives, activities, and evaluation criteria to be used in deciding whether these objectives have been achieved.

A. Activities

This section lists in detail the activities to be undertaken in your research — for example, background research, data collection, analysis, design, coding, testing — and how these activities relate to the project's objectives. You must make a realistic estimate of how much time will be required to undertake each phase of the project, given the other claims on your time. You should also demonstrate that you have identified and allocated sufficient time to critical project activities — those that must be completed if the project is to continue and be completed on time. You must also discuss alternative or contingency actions you would take should something go wrong at various steps in your project.

B. Schedule

To illustrate the sequence of activities, and especially the allocation of time to critical activities, you should develop a time line, Gantt chart, or other graphic representation of the schedule that provides a holistic presentation of both sequential and concurrent activities. Be sure to include the required thesis documents for STS 401 and 402.

C. Personnel

This section establishes the network of collaborators you have developed to accomplish your goals. To this end, you should explain the roles to be played by you, your technical advisor, your STS advisor, graduate students, and other technicians. You should indicate what sort of help, advice, or information you expect to receive from your technical advisor and how frequently you will meet with him or her.

D. Resources

This section should describe the resources needed for the project, including equipment, computer time, laboratory access, and use of published literature. You should discuss contingency plans should one or more key resources be unavailable.

V. Expected Outcomes

This concluding section should summarize what you expect to have accomplished when you submit the thesis and what future work may be undertaken to fully achieve the desired benefits of the project. How will you know when your project is completed? What criteria for evaluation will you use to establish its success or failure? In your proposal, you should be as specific as possible about the sorts of results you expect to obtain. You should remind the reader that this project meets a real need and makes a valuable contribution to society.

VI. Bibliography

This section should include all sources cited in the body of the proposal as well as additional key references you plan to use in the course of the project. As was mentioned earlier, you should aim for a minimum of 15 sources. The list might be grouped by topic (e.g., historical background, theory, methodology, applications, and societal context) to show that you have found sources that explore the various aspects of your project. There are some circumstances in which your instructor or the conventions of your field may call for separate lists of "Works Cited" and "References."

If there are aspects of your sources or of your bibliography as a whole that require explanation, you may include annotations, that is, two- to four-sentence descriptions of each source's primary content, quality, and relevance to your project. Alternatively, you might add a bibliographic note outlining features of the literature or of particular sources that might be of interest to your readers.

VII. Required Appendices

A. Budget and Equipment Checklist

If your project requires an expenditure, you must indicate how much you intend to spend and where you will get the money. If your project requires specialized equipment, you must indicate whether the equipment is currently available at the University of Virginia and, especially, whether you will be able to gain access to this equipment. If you must purchase equipment for this project, you must indicate whether you can reasonably expect the equipment to arrive in time for you to complete the project. Failure to obtain the needed equipment on time will not be adequate grounds for an extension on the due date of the thesis.

B. Biographical Sketch of Student

In this section, you establish your qualifications and credentials to undertake the proposed research or design project. You may also discuss why this project is important to you personally.

C. Preliminary Outline of Thesis

This section should include the working title of your thesis, the titles of the major sections of your report, and one or two sentences describing what you think may go into each section. The preliminary outline must be completed at some point during the semester, but it is not required with the original submission of the proposal.

ORAL PRESENTATIONS

Guidelines

You will give an oral presentation in both STS 401 and 402. In STS 401 you will be required to deliver an oral presentation on your proposed thesis project. In 402, the oral presentation is given after you turn in your final thesis, on the subject of your completed thesis. Both oral presentations should follow accepted principles of oral communication of technical information and be adapted for the specific circumstances of the STS 401/402 class.

Two ground rules are of special importance for presentations in STS 401/402:

1. The audience consists of students majoring in the fields of engineering and applied science at SEAS, the STS instructor, and, if invited by the student and STS instructor, the technical advisor, also.

2. A time-limit will be imposed for the presentation itself, followed by two or three minutes for questions and comments at the end of the report.

(See Appendix H for specific guidelines on giving oral presentations.)

UNDERGRADUATE THESIS PROJECT PROPOSAL
School of Engineering and Applied Science
University of Virginia

A Temperature Control System

for a Research Wind Tunnel

Submitted by

Andrew Barrett

Mechanical Engineering

Indicate group here if applicable

STS 401

Section 7 (10 a.m.)

October 26, 1998

On my honor as a University student, on this assignment I have neither given nor received unauthorized aid as defined by the Honor Guidelines for papers in Science, Technology, and Society courses.

Signed _____

Approved _____ Date _____
Technical Advisor – *Type Advisor's Name*

Approved _____ Date _____
Science, Technology, and Society Advisor – *Type Advisor's Name*

PART 4: TOPIC STATEMENT, PRE-PROPOSAL AND PROPOSAL APPROVAL FORMS

The following pages are copies of the forms that are used for the topic statement, pre-proposal and proposal approval, and may be copied directly out of the Undergraduate Thesis Manual. These forms are also available as PDF files on the STS web site.

FOURTH YEAR THESIS TOPIC STATEMENT

Student_____ Email _____

STS Advisor_____ Email _____

Technical Advisor_____ Email _____

Topic (one sentence):

Key question, problem, or need the research or design will address (one sentence):

Why the project is important:

Research methods or design strategy:

Will this project use human subjects (circle one)? Yes No. If yes, see University of Virginia policies at the sites of (a) the Human Investigations Committee, which oversees this issue for the UVA health system (<http://www.healthsystem.virginia.edu/internet/hic>) and/or (b) the Institutional Review Board for the Social and Behavioral Sciences (<http://www.virginia.edu/vprgs/irbsbs.html>).

Three key references (such as books, articles, or research papers suggested by student or technical advisor):

1.

2.

3.

I agree to be technical advisor for this project. The topic seems both challenging and manageable. (A general picture is sufficient. Details will be worked out in the pre-proposal and proposal. The final report is due in March.) I agree to meet regularly with the student, help the student solve problems as they arise, and evaluate thesis-related documents (pre-proposal, proposal, progress report, and final report). I understand that all thesis documents and presentations are public, and that the final thesis report will become part of the UVA library collections. The student and I have agreed on how, and by whom, any other products or information may be used.

Signature of technical advisor: _____ Date_____

Position/title_____ Department_____

I agree to carry out this project in a professional and ethical manner. I will meet regularly with my technical advisor, work alone or with him or her to solve problems as they arise, and submit thesis-related assignments on time. My advisor and I have agreed on how, and by whom, all products or information produced may be used. I take responsibility for obtaining resources and managing my project.

Signature of student:_____ Date_____

FOURTH YEAR THESIS PRE-PROPOSAL APPROVAL

Student_____ Email _____

STS Advisor_____ Email _____

Technical Advisor_____ Email _____

Title of project:

_____I approve this pre-proposal. The student should proceed to the full proposal.

_____I do not approve this pre-proposal because:

Signature of technical advisor: _____ Date_____

STS ADVISOR'S EVALUATION OF THESIS PROPOSAL

Student _____ Email _____

STS advisor _____ Technical advisor _____

5 = Excellent; 4 = Good; 3 = Average; 2 = Poor but still acceptable; 1 = Unacceptable

5 4 3 2 1 **Introductory sections:** Title Page, Table of Contents, and Abstract or Executive Summary (contains all necessary information following format in thesis manual; provides reader with clear overview of rest of report).

5 4 3 2 1 **Rationale and Objectives** (identifies thesis topic; establishes its significance and context; supports arguments with evidence and references; lists objectives).

5 4 3 2 1 **Preliminary Analysis of Social and Ethical Contexts** (identifies and analyzes motivational, social, and ethical dimensions of project grounded outside technical skill; discusses organizational and cultural dimensions of the problem and issues of implementation; balances breadth and depth; supports arguments with evidence and references).

5 4 3 2 1 **Review of Technical Literature** (demonstrates mastery of published technical literature; explains how project will build on and surpass others; supports argument with evidence and references).

5 4 3 2 1 **Project Activities:** Activities, Schedule, Personnel, and Resources (presents logical, realistic, and complete steps to completion of thesis).

5 4 3 2 1 **Expected Outcomes** (defines success and ways to measure it).

5 4 3 2 1 **Bibliography** (includes 15 authoritative/hard copy sources minimum in proper style).

5 4 3 2 1 **Required Appendices:** Budget and Equipment Checklist, Biographical Sketch of Student, and Preliminary Outline of Thesis (supplements and elaborates on material in text concisely yet completely).

5 4 3 2 1 **Illustrations** (clarify material in text; are properly labeled and sourced).

5 4 3 2 1 **Presentation** (demonstrates professional skill with format, grammar, diction, style, organization, pagination, spacing, font size, and margins).

5 4 3 2 1 Ability to **identify, formulate, articulate, and solve engineering problems**; think critically about problem definition, engineering design, and project management.

5 4 3 2 1 Ability to **communicate effectively** with both expert and non-expert audiences.

5 4 3 2 1 Ability to **understand the impact of engineering solutions in a global and social context** and use of that understanding in the formulation of engineering problems, solutions, and designs.

5 4 3 2 1 **Overall Persuasiveness** (makes a persuasive case that problem chosen is significant and not adequately addressed at present; presenter has a comprehensive and sophisticated view of the problem, a viable approach and detailed plan, a clear idea of what will constitute success, and the qualifications and other resources needed).

GRADE:_____

( ) **Approved.** Correct typographical/mechanical errors.
( ) **Not approved at this time.**

TECHNICAL ADVISOR'S APPROVAL OF UNDERGRADUATE THESIS PROPOSAL

Student TYPES or PRINTS items I – IV.

I. Student's Name _____ Email _____

II. Working Title of Project

_____

III. STS Advisor _____ Email _____

IV. Technical Advisor _____ Email _____

Title/Position _____Department _____

Technical Advisor: Please complete Items V and VI, and then sign and return the form to the student's STS advisor.

Requested RETURN DATE:

_____

V. The technical advisor's evaluation is important in assessing the quality of an undergraduate thesis proposal. Please use a scale of 5 (excellent) to 1 (unacceptable) to evaluate this thesis proposal.

5=Excellent 4=Good 3=Average 2=Poor but still acceptable 1=Unacceptable

5 4 3 2 1 ***Quality of Relationship with Technical Advisor.*** Evaluates the extent to which
the student maintained a professional relationship with the technical advisor through the process of preparing the proposal. Includes working with the advisor on the selection of a thesis topic, and meeting expectations on which advisor and student have agreed.

5 4 3 2 1 ***Technical Difficulty and Overall Challenge of the Proposed Thesis Project.*** Judges the relative challenge that the proposed project presents in terms of the amount and difficulty of technical work required.

5 4 3 2 1 ***Success in Completing the Proposal.*** Assesses how well the student proceeded from identification and selection of the topic, through the needed background research, as well as the student's effort, diligence, ingenuity, and thoroughness.

5 4 3 2 1 ***Overall Technical Quality of the Proposal.*** Evaluates the proposal from an expert's point of view.

VI. Please circle numbers of the appropriate item(s):

1. I have read this proposal and agree to be the technical advisor for the project, with the understanding that the student will confer with me regularly during the course of the project.

2. I would agree to be the advisor if the student would satisfactorily address points in the proposal, as indicated below.

3. I believe this project, as described, is unacceptable and would not challenge the student's abilities.

4. I believe this project is beyond the scope of the student's abilities and should not be attempted.

5. This project requires materials, equipment, or facilities not available to the student.

Further Comments:

_____

_____

_____

_____

_____

Advisor's Signature _____ Date _____

Please check if you wish to confer with STS Advisor _____
And /or student _____

If you approve the proposal, please also sign the title page. Student will retain signed title page for final binder.

Revised 1 November 2005

PART 5: STS 402

PROGRESS REPORT

Nature and Purpose

The progress report summarizes the work completed on the project to date and the work which is yet to be done. It is typically *500 words* long and is submitted to both advisors; it may be followed by interviews with the advisors.

For the writer, the progress report provides the opportunity to make a careful assessment of the work completed and the work yet to be done on the project. For the advisors, the report provides an opportunity to review in writing the current state of the project and to offer suggestions on how the remainder of the work to be done might be carried out. It also gives the advisor the chance to review the feasibility of any modifications the student proposes for the project.

What to Include

1. **Introduction**. A paragraph reviewing the nature of the project begins the report. This need not include the background information or justification for the project but should state concisely the main purposes of the project.

1. **Body**. The following items are to be included in this section:

    a. review of the **work done** to date
    b. review of the **work remaining** to be done
    c. discussion of **anticipated problem areas**

2. **Conclusion**. This should be a brief summary statement about expectations for completion of the work on the project. Include discussion of any problem on which you would like your advisors' advice or other assistance.

3. **Work schedule charts**. Include a copy of the original schedule from the proposal, with any necessary revisions clearly delineated. Changes should be noted in red ink or felt-tip marker; if changes are extensive, create a new schedule. (See Appendix F for sample Gantt chart.)

4. **Printout verifying that you have entered your thesis in the Undergraduate Thesis Project Database for 2003-2004.** You can reach this database through the STS department Web page. Your instructor will provide you with the URL you need to enter your thesis in the database.

THESIS OUTLINE

Outlining

Keep in mind that the outline is not a contract that must be strictly adhered to, but a blueprint or guide that may change in the final stages of writing. In planning your outline, you may wish to use the Scientific Method as a rough model for the deep structure underlying your organization (but not explicitly referred to on the surface): Problem, Hypothesis, Method, Data, and Results.

The most important function of either the topic or the sentence outline is to indicate the relationships of the ideas that you will present in your final report. Either of the outline styles shown below will allow you to distinguish between major and subordinate ideas, between what includes other ideas and what is included in other ideas. Finally, try to keep the outline balanced—do not make any sections much more detailed than others.

An outline requires you to plan the structure of your final report. Because students with different learning styles tend to plan their writing in different ways, we have presented two broad options for how to approach this assignment. Your instructor may require one or the other, or may further narrow either option. Whichever type of outline you write, this assignment will help you prepare in three ways for the final draft by:

1. bringing to mind the overall content and order of the major parts of your final report, the logical relationships between them, and how they might best be connected — i.e., visualizing the "big picture"

2. revealing areas of research that need further development; and

3. beginning to put your thoughts on paper in complete sentences, to get a sense of the continuity and style of the final report as well to obtain preliminary feedback from your instructor

Option 1: Topic Outline and Partial Draft

Revise and refine the topic outline included in your proposal, with tentative chapter titles at the top level and specific planned sections and parts of sections at subordinate levels. Use this as a springboard to writing a rough draft of one or more chapters of your final report.

Option 2: Sentence Outline

Revise and develop your topic outline using complete sentences instead of words or phrases. A well-written sentence outline will resemble an abstract, having almost the same degree of continuity from one sentence to the next, but it will make use of certain formatting features that indicate even more pointedly than an abstract the logic of the content and order of the ideas. The finished product should be approximately two to three pages long.

Acceptable Outline Styles

Roman

i. Chapter One: Chapter title
- A. Major section heading or summary
- B. Indent and capitalize each entry.
  1. Broad area or paragraph within section
  2. Each level of ideas is included in the level above.
     a. Individual paragraphs or points within paragraphs
     b. In the sentence outline only, periods are used at the end of each entry.
        1) You may not need to go to this deep a level.
        2) Etc.

ii. Most word processing programs have an outline function that will automatically renumber all entries whenever one is added.

Numerical

1.0 Chapter One: Chapter title
- 1.1 Section one within chapter one
- 1.2 Section two within chapter one
  - 1.2.1. First point or paragraph within section one
  - 1.2.2. Second point or paragraph within section one

2.0 Chapter Two: Chapter title

The majority of entries should be **specific to the content of your report rather than generic to any report** (e.g., "Introduction" or "Theory"). In addition, because the outline is a way to show branching of ideas, there should be more than one offshoot at each branching point. So, you should not have an item *1.* without an item *2.,* or an item *a.* without a *b.*

Example:

- A. Plastic tubing chosen over copper
  1. Less expensive
  2. More available locally
  3. *Easier to form accurately*
     - *a. Internal dimensions do not change in bends*
- B. Tubing dimensions

In this example, the writer did not recognize that "*form accurately*" and "*do not change in bends*" are two ways of saying almost the same thing. The outline would be more logical if item *a.* were dropped and the information included in *3.*, as follows: "*Easier to form without changing internal dimensions in bends."*

THE FINAL REPORT ON THE THESIS PROJECT

Nature and Purpose

The Final Report on the Undergraduate Thesis Project (referred to hereafter as "the thesis") is the final written work connected with the project. It presents background information necessary to understand the project, the reasons the research was undertaken, the methods employed to conduct the research, the results of the research, and an indication of how the results might be employed, including recommendations for further research where appropriate. It provides a degree of detail and explanation sufficient for an intelligent reader interested in the topic to be able to read it from beginning to end finding clear explanations for what was done and why.

The first submission of the thesis should be securely stapled or in an envelope, depending upon your instructor's wishes.

Parts of the Thesis

Each chapter should begin a new page and should bear a title heading, ordinarily in full caps.

Sections of chapters will usually be set off by capital and lower-case headings in the text, centered between the type groups, but sections do not begin new pages. Chapter and section headings should represent a carefully worked out, logical scheme and, when properly done, aid the reader in perceiving what steps are coming next and the relationship of each new step. They also help the author by making clear transitions from step to step.

The following is a detailed list of the parts of the thesis. Except where a part is listed as optional, every report must include all the parts shown:

Frontispiece (optional)

This is a full-page illustration of some key feature of the apparatus discussed in the paper. Suitable captions should, of course, be used. The frontispiece may face the title page directly or, preferably, have an intervening blank sheet. No page number.

Title Page (sample at the end of this section)

Both advisors' names should be typed, with consistent honorifics (Professor for both, or Doctor for both, but not a mixture). The title itself should be clear, accurate, complete, and concise. No page number.

Preface or Foreword (optional)

This is where you put the explanation of your own reason for writing the paper, the basis of your interest in the subject, the purpose of the discussion, special features of organization, limitations on the content or completeness, and acknowledgements of aid. The preface is your personal contact with the reader, expressing your views and feelings.

Financial or other aid from the Engineering Council, VEF, research grants, departmental stipends, etc., should be acknowledged at this point. Start numbering pages here using lower case roman numerals and continue with roman numerals through the abstract.

Table of Contents

The table of contents provides, at a glance, a complete view of the paper (with page numbers in Arabic) and the divisions of prefatory or appendix material (with page numbers in small Roman numerals). The table of contents is intended to present a logical view of the complete paper and to anticipate the relationships of the various sections, so the reader can see how the paper is laid out and can find any specific section. Consequently, the chapters should be listed and titled, and special parts (such as the index, glossary, correspondence, or bibliography) should appear.

List of Figures and List of Tables (may be omitted if the number of either is small)

Include the figure number, title, and page on which the figure appears.

Glossary of Terms

A glossary of terms should be included when specialized terms are used in the thesis; even though they are explained the first time they are used in the text. A glossary can be an invaluable aid to the reader, but it is important to keep in mind that it summarizes, rather than replaces, definitions in the text. Include quotation marks and source citations where appropriate.

Abstract

The abstract fills in details of structure suggested by the table of contents and provides a well-proportioned and properly emphasized overall view of the paper, including the introduction, body, and conclusions, in one page or less. It should be written after the paper has been completed, for only then is the writer in a position to boil down or condense the work in the required brief form. In another sense, however, the author literally abstracts by presenting points that are particularly necessary to convey an understanding of the context of the paper, its meaning, and its likely employment.

The abstract is written with complete sentences in paragraph form. It need not follow the organization of the whole paper but should provide an effective, quick review of the contents. The abstract must be tightly and compactly written, but care must be taken that it is clear and complete within itself. Necessary definitions, key figures and quantitative data should be provided. Writing that is too far divorced from the facts or too compressed may be obscure.

Introduction

The introduction, which is the first chapter, provides the background information and content needed to understand the paper and shows that there is adequate justification for the writing of such a thesis. It gives in a quick, neat fashion the trend of events or

methods employed up to the time of work or device under discussion. The introduction is intended to relate the subject to the readers and to narrow the reader's conception from the general field of interest to the particular focus and direction that the paper itself is to have. In short, the introduction sets up the specific materials that follow, giving them order and point, and defines both what the author is including and what he or she is excluding. The introduction puts the reader in such a position that he or she cannot miss the point. Finally, the introduction indicates how the body of the paper will be organized. Numbering starts with Arabic number one (1) for the first page of the introduction. Ordinarily, the number 1 is not printed on the first page.

Discussion of Social and Ethical Dimensions of the Project

Your thesis must contain a discussion of the social and ethical issues related to the topic of the thesis. You have the option to present this discussion in a separate chapter or section or to integrate it with other sections or chapters of the thesis. For example, the rationale for projects often involves solving a social problem, fulfilling human needs, or improving the lives of individuals. Thus, the rationale could be developed into a discussion of social and ethical issues. Another possibility is in the discussion of the implications of your findings; this could involve a discussion of social uses and social issues addressed by the knowledge or product your thesis developed. There are no hard and fast rules for where to place your discussion of social and ethical issues. What is best depends on the particular project and the flow of the narrative that you develop for the thesis.

Conclusion

The conclusions chapter is devoted primarily to the significance and interpretation of the facts rather than to a presentation of the facts themselves, which will have been presented in earlier chapters. In cases where the results require more than a paragraph or two of discussion, that material should be presented in a discussion of results chapter that precedes the conclusions chapter.

The introduction foreshadows and anticipates the direction of the investigation and indicates the principal topics, order of presentation, and scope of the paper. **The conclusions section, in contrast, presents the material in terms of the reader's knowledge of details gained from the paper.** The introduction prepares the reader to digest information; the conclusions chapter assumes the reader's full awareness of terms, of relationships, and of quantitative data. Hence, the conclusions chapter places important points in their true relationship to one another and ties together all the diverse threads that have been woven in the text. It accomplishes these tasks in three required sections, each of which has a distinct purpose:

(1) Summary

The conclusions chapter should begin with a clear, concise, unbiased factual summary of the data and findings presented in the preceding chapters. The summary contains what the writer knows and has produced, as distinguished

from what he or she thinks, infers, or feels. It groups and emphasizes the important points that the author has made in the text, offers a clear view of the project's primary finding or product, and opens the way for interpretation of results.

(2) Interpretation

With the factual summary completed, the interpretation section puts the key findings or product of the project in perspective by both establishing significance and recognizing limitations. It moves beyond the key finding or product of the project to draw conclusions, develop the suggestive features of that finding or product, and offer a self-critique of the project's results. In so doing, it brings out features that are often fairly obvious to the writer but difficult for other readers to grasp. It answers questions such as: How well did the project achieve its original goal? How accurate and complete are the results? Why are the results useful and significant? What are the strengths of the project's final product? What are its weaknesses or limitations? How much do the weaknesses or limitations matter? (If they do matter, remedies will typically be suggested in the recommendations section that follows.)

(3) Recommendations

The third section of the conclusion (an optional one in some instances) presents recommendations for action. Some of these recommendations will follow logically from the assessment presented in the interpretations section; others will derive from the analysis of social, ethical, and human dimensions of the project that was presented in the proposal.

To begin the section, the author typically indicates what additional work should be done and what direction further investigation should take. For example, the author may point out additional data that would be useful to have or suggest changes, expansion, or revision of the methods used or studied in the project. The recommendations should also include suggestions for the implementation and long-term management of the project's results, including monitoring of potential negative impacts and the consideration of the social and ethical contexts of the project. The author need not present solutions for any problems identified but should alert decision-makers to issues that may need to be addressed. Perhaps most importantly, the author should take the opportunity to convey the long-term benefits and comprehensive improvement that may result from successful implementation of the results of the project. Having covered the strictly factual elements earlier, the author has the freedom in this section to exercise a greater degree of imagination in envisioning the positive potential of the project.

The conclusion, then, summarizes the facts presented. It interprets the facts in terms of their relative importance, placing emphasis where emphasis is due, and it points out

opportunities and applications that would make profitable and fruitful the work previously done.

Bibliography

The bibliography serves to indicate the foundation of the writer's knowledge of the subject and to allow a reader to seek further information on the subject. For both these reasons the bibliography should be complete and accurate. It should contain information specific enough to allow the reader to locate each source. It should list the books, journal articles, pamphlets, and monographs used and, in addition, complete data on personal interviews and correspondence. While annotation (brief descriptions of content of the entry and comment on its value) is desirable as an aid to the reader's further research, it is not mandatory.

Appendix

The appendix is the last important section of the paper and includes all materials that do not fit into the front matter, the introduction, or the body of the paper. Such material may include outlines, diagrams, illustrations, conversion tables, detailed calculations, computer printouts, or correspondence. Appendices should be noted in the table of contents. Your STS advisor will provide guidance on page numbers for appendices.

Page Length for the Thesis

The text of the thesis should not ordinarily exceed 25-30 double-spaced pages, excluding illustrations. You must obtain explicit permission from your STS advisor to exceed this limit.

Sample Format of Thesis

I. Introduction (Chapter One)

- **i.** One- or two-sentence **summary of** (a) **what**, (b) **how**, and (c) **why** ("thesis of your thesis.")
- **ii.** **Problem Definition**:
  - A. **Context**: circumstances, findings, problems, needs that gave rise to the work, facts.
  - B. **Concepts**: relevant theory and important, useful terms.
- **iii.** **Literature Review**: Relatively brief discussion of previous work and chief contributions of others presented chronologically and leading to rationale for and scope of the project. In most theses, there will be an entire chapter later in the thesis that is devoted to a review of the relevant literature. (See Appendix B for sample.)
- **iv.** **Rationale for and Scope of the Project**: Shows how your contribution fits in, exactly what you are contributing, and what is novel about it.
- **v.** **Overview of Contents of the Rest of the Report**: Conceptual rather than structural.

II. Text or Body of Thesis

The text, or body of the thesis, presents the facts, the results, the discussion, and comparisons or interpretations of the results. It presents data and details, including statement of method, description of apparatus, process, or equipment concerned.

For clarity and for the reader's convenience, the body of the thesis is divided into chapters, which represent some general pattern of presentation based on the underlying logic of the project itself. Here is *an example*:

Chapter 2: Literature Review

Chapter 3: Societal Context and Ethical Implications (Often included as a part of the introduction. Sometimes situated before conclusion.)

Chapter 3: Materials and Methods

Chapter 4: Results

Chapter 5: Discussion of Results

III. Conclusions (Final Chapter)

Summary of Form and Content of the Thesis

The parts of the report and their functions may be summarized as follows:

***Title Page:**
Gives title, department, author, date, Honor Code pledge, author and advisor signatures

***Preface:**
Clarifies the author's relationship to the project and carries any acknowledgements the author wishes to make

***Table of Contents:**
Outlines structure of the paper and location of its parts

***Glossary of Terms:**
Defines key terms for reader's reference

***Abstract:**
Presents the report in miniature, emphasizing the important ideas and recommendations, if any

Introduction:
Sets forth the history, background, scope and method of study

Body of Report:
Develops specific ideas and information by exposition, discussion, or comparison and contrast

Conclusions:
Provides in three parts:

Factual summary
Interpretations
Recommendations

***Bibliography:**
Cites all sources and additional available literature with critical comment when helpful

***Appendices:**
Adds auxiliary or supplementary materials or those not directly relevant, such as correspondence or reprints which are too valuable to be discarded

*Items marked with an asterisk are not included in the page limit for the thesis.

TITLE OF THESIS

A Thesis
in STS 402

Presented to

The Faculty of the
School of Engineering and Applied Science
University of Virginia

In Partial Fulfillment
of the Requirements for the Degree

Bachelor of Science in _____
(Author's field of Engineering and Applied Science)

by

(name)

(date)

On my honor as a University student, on this assignment I have neither given nor received unauthorized aid as defined by the Honor Guidelines for papers in Science, Technology, and Society courses.

_____
(Full signature)

Approved _____ (Technical Advisor)
Type Advisor's Name (Signature)

Approved _____ (Science, Technology, and Society Advisor)
– *Type Advisor's Name* (Signature)

THESIS DUE DATE

On the specified due date on the STS 402 syllabus, the student will present two copies of the thesis project final report to the Science, Technology, and Society (STS) instructor. Each copy should be accompanied by a properly filled out evaluation form (See Part 4). The instructor will initial and date both copies, and one copy will be taken **by the student** to the technical advisor for the project. The STS and technical advisors will review the copies concurrently.

Students can expect reading and return of final reports to take approximately one month. *The version you submit on the due date is the version on which you will be graded.* Depending on the policies and preferences of your individual instructor, you may be required or given the opportunity to revise the report, but not necessarily for a new grade. The opportunity to revise is not an entitlement. If your original submission is deemed unacceptable and you are instructed by your advisor(s) to revise and resubmit your report, you must take the initiative to meet with your advisors, determine what needs to be done, and remedy any deficiencies.

The due date for the thesis (Final Report on the Undergraduate Research Project) is a firm date for all sections of STS 402, and extensions for completion of the report will normally not be granted except for reasons of ill health or other personal matters beyond the student's control. In any event, the student must apply for the extension in writing at least a week before the due date, both advisors receiving copies of the request. Both advisors must agree to grant the extension.

Extensions will not be granted if the student was simply not able to complete the project in the time available.

PART 6: THESIS APPROVAL FORMS

The following pages are copies of the forms that are used for the final thesis approval, and may be copied directly out of the Undergraduate Thesis Manual. These forms are also available as PDF files on the STS web site.

TECHNICAL ADVISOR'S EVALUATION OF UNDERGRADUATE THESIS

Date _____

Student _____ Email _____

Technical Advisor _____ Email _____

STS Advisor _____ Email _____

The technical advisor's evaluation is very important in assessing the overall quality of an undergraduate thesis. Please use a scale of 5 (excellent) to 1 (unacceptable) to evaluate this thesis based on the criteria outlined below. In the Comments section below, please indicate the reference group—other fourth-year SEAS students, fourth-year students in the student's major field, etc.—that you used when evaluating this thesis.

When you have completed the evaluation, please return it to the STS Advisor by _____.

5 = Excellent 4 = Good 3 = Average 2 = Poor but still acceptable 1 = Unacceptable

5 4 3 2 1 ***Quality of Relationship with Technical Advisor***. Evaluates the extent to which the student maintained a professional relationship with the technical advisor. Includes keeping the advisor informed on the status of the project, meeting expectations on which advisor and student have agreed, and dealing straightforwardly with difficulties that arise.

5 4 3 2 1 ***Technical Difficulty and Overall Challenge of the Task Undertaken***. Judges the relative challenge that the project presented in terms of the amount and difficulty of technical work required.

5 4 3 2 1 ***Success in Completing the Task***. Assesses how well the student achieved the goal he or she set out to achieve, or, alternatively, the student's effort, diligence, ingenuity, and thoroughness, even in instances where the project's goals were not fully achieved.

5 4 3 2 1 ***Overall Technical Quality of the Thesis***. Evaluates the project from an expert's point of view.

5 4 3 2 1 ***Independent Learning***. Assesses the extent to which the student, based on performance in the thesis project, demonstrates an ability to engage in independent and lifelong learning.

Comments: (Continue on the back or send comments by email, if you wish.)

Do you approve this thesis?	**Yes**	**No**
Was this thesis part of a project course in the major field?	Yes	No
Would you like to discuss my work with my STS Advisor?	Yes	No

Signature: _____ **Date:** _____

IF YOU HAVE APPROVED THE THESIS, PLEASE ALSO SIGN THE TITLE PAGE OF THE THESIS.

SCIENCE, TECHNOLOGY, AND SOCIETY ADVISOR'S EVALUATION OF THESIS

Student _____

STS Advisor _____

Technical Advisor _____

5 = Excellent; 4 = Good; 3 = Average; 2 = Poor but still acceptable; 1 = Unacceptable

5 4 3 2 1 ***Overall Design***: Is imaginatively conceived, thoroughly researched, convincingly expressed, and/or potentially significant.

5 4 3 2 1 ***Introduction***: Establishes meaningful context and significance of project for multiple audiences; grounds research thoroughly in literature; clearly defines problem and scope; explains key concepts; previews structure of rest of report.

5 4 3 2 1 ***Methods***: Adequately justifies and clearly describes project design.

5 4 3 2 1 ***Results***: Presents data with verbal and visual clarity; emphasizes central research finding; fully explains and illustrates design and use of final product or conclusion.

5 4 3 2 1 ***Discussion of Technical Results.*** Interprets and evaluates data or product in light of the project's hypothesis or goals.

5 4 3 2 1 ***Discussion of Social and Ethical Dimensions of the Project****:* Analyzes the social and ethical motivations and implications of the project; outlines an approach to monitoring the project results, including unintended consequences; discusses key issues of implementation and long-term management, especially those involving professional and ethical responsibility.

5 4 3 2 1 ***Conclusion***: Reaches synthesis related to context established in introduction; summarizes extent to which project met goals; recognizes limitations of this research; and makes recommendations for future work, including social and ethical considerations.

5 4 3 2 1 ***Organization***: Divides report into unified and coherent chapters, sections, and paragraphs; features transitions that link each chapter to the whole and establish flow between sentences and paragraphs.

5 4 3 2 1 ***Graphics***: Includes enough appropriate and clearly understandable figures and tables. Graphics are well integrated with text, adequately interpreted, clearly labeled and captioned, large enough, and printed darkly.

5 4 3 2 1 ***Documentation***: Adequately supports argument with references cited in the text, using correct and consistent style; includes a bibliography (or works cited) that shows depth, breadth, and correct form.

5 4 3 2 1 ***Style***: Is clear, concise, readable, mature, and polished, with a minimum of grammatical errors.

5 4 3 2 1 ***Mechanics***: Includes meaningful and consistent chapter and section headings; uses proper formatting conventions; features numbered pages, standard capitalization, and a minimum of typographical errors.

5 4 3 2 1 ***Communicates effectively*** with both expert and non-expert audiences.

5 4 3 2 1 ***Exhibits an understanding of the impact of engineering solutions in a global and social context*** and uses that understanding in the formulation of engineering problems, solutions, and designs.

5 4 3 2 1 ***Shows an understanding of professional and ethical responsibility*** as it applies to particular engineering projects and to the profession as a whole

5 4 3 2 1 ***Supporting Documentation***:
Title: Is accurate, complete and concise.
Abstract: Is a miniature of report, summarizing the argument and conclusions.
Table of Contents and List of Figures: Is neat and complete.
Glossary: Is informative, helpful and grammatically consistent.
Appendices: Are informative and neatly presented

APPROVED _____ DATE _____
(STS Advisor's Signature)

GRADE _____

FINAL ASSESSMENT FORM

Thesis Author _____

Thesis Title _____

_____ ***Not approved at this time***. Revision required according to comments below and on reverse. Submit rewrite with this evaluation, technical advisor's evaluation, and original report.* Note: Revision is at the discretion of the advisors. Students are not guaranteed the opportunity to revise their theses to make them acceptable

_____ ***Approved, provided*** typographical/mechanical errors are corrected; ***revision is recommended*** to improve grade, but is not required. Submit rewrite with this evaluation, technical advisor's evaluation and original report.

_____ ***Approved***. Correct typographical/mechanical errors for final binder.

GRADE: _____

CONTENTS OF THE FINAL BINDER

The Final Report, along with the other written assignments connected with the Undergraduate Thesis Project, is put in a binder and placed in the Science and Engineering Library as both a permanent record of the student's work on the thesis project and as a record of research available for any interested reader.

Insert this sheet unbound in the very front of the final binder. The items should be ordered as they are listed below. Individual documents should have page numbers, but there is no need to merge the documents so that the pages are numbered consecutively throughout the binder.

Check off every item in the space at the left except those that you have not included. If an item is not included in the binder, use the space below to provide an explanation. Original graded versions of documents may be included in the binder; clean, corrected copies are preferred. ***Be sure that all required signatures are in place, including your own***.

Use the space below to call the instructor's attention to revisions to the final report that he or she may not have reviewed previously with you.

_____ A neatly typed cover label or page showing the title of the project, the date, and your full name.

_____ A table of contents for the final binder.

_____ Resumé or brief autobiographical sketch (optional)

_____ The Final Report on the project. (Make certain that the technical advisor's signature appears on the title page, along with the Honor Code Pledge and your signature in full.)

_____ The Proposal, with advisors' signatures and signed Honor Code Pledge on title page.

_____ The Pre-proposal (optional).

NOTE: The binder itself must be a type employing a means of retaining the papers securely. Do not use a spring-loaded type, as it may come apart and drop out the papers. Do not use a loose-leaf or ring-type binder.

Explanations on missing documents or notes to Science, Technology, and Society instructor (include page numbers with notes on Final Report):

APPENDICES

APPENDIX A: SAMPLER OF INVENTION STRATEGIES

The central purpose of all methods of invention is to contact and release the wellspring of creativity within each one of us. No one method is better than another; try them out and see which works best for you. These techniques should all be accompanied by complete open-mindedness and acceptance of new ideas, no matter how crazy. Turn off the critic for this stage of the writing process.

Free writing: associative, stream-of-consciousness writing with no deliberate focus. "Looping" involves a series of timed (5-10 minute) freewrites; after each, pick out a key concept from the previous writing and focus next writing on that.

Brainstorming: focused, goal-directed listing of all ideas remotely related to topic. Effective with groups. Can be done on note cards. Review to look for focus, eliminate extraneous items, and group related items.

Clustering: creating a visual "network" or "web" on the page, with related ideas grouped together. Put topic in center of page and branch out from there. Make a separate bubble for every idea. Draw connections. Keep going until the urge to write becomes strong, then just start writing.

Inventory: writing answers to questions which will help you discover personal connections to topic.

> What do I know about the topic?
>
> What don't I know about the topic?
>
> What images or memories does the topic evoke for me?
>
> If I were to make this topic into a movie, what would the opening scene be like?

Cubing: looking at a topic from different points of view (analogies) to find new approaches:

> ***Direct Analogy***: compare to something concrete. *A computer is like a slave which will do whatever I command or like a sympathetic friend who fixes my mistakes without criticism.*
>
> ***Personal Analogy***: imagine you are the topic or solution. *I like to serve others. I am smart about figuring things out but don't have much imagination (yet). I am a synapse. I buzz, whir, beep, and rattle.*
>
> ***Symbolic Analogy***: compare to an abstract principle. *The advent of the computer is like a second industrial revolution, increasing production in all fields and freeing people from boring menial tasks; it is like Prometheus with his gift of fire.*

APPENDIX B: LITERATURE REVIEWS

Five Steps to a Professional Literature Review

I. Orient yourself

1. Seek out **a few high quality sources** that can serve as good introductions to your subject and the literature on it. **Ask your technical advisor** about sources that would be particularly useful in giving you the technical background you need for your project. Search for **previous undergraduate theses** in subject areas related to your own. **Reference works** such as subject dictionaries and encyclopedias can also help you get oriented.

2. **Proceed to books**, which will cover the topic in detail but will not be particularly up-to-date because the publication process takes considerable time.

3. **Explore conference proceedings and journal articles**, which are more up-to-date and precise, but may require broader subject understanding to determine the relevancy of the paper to your topic.

4. **Look in specialized sources** such as patents, technical reports, standards, preprints, and datasets. When you get to this stage, you will probably need assistance from a librarian.

5. Look in the *Applied Science and Technology Abstracts*. You might also search Lexis-Nexis *Academic Universe* to find out what is new (and newsworthy) concerning your topic. In *Academic Universe*, you can locate the full text of articles from many newspapers, including the *New York Times* and the *Washington Post*; you can also retrieve articles from trade and industry publications. The *Christian Science Monitor* enables full-text retrospective searches to the late 1960s.

Searching the literature is **iterative** rather than linear. You may go through the range of sources available several times as you get a successively clearer idea of the search terms and approaches that yield the best results.

II. Arm yourself with search concepts and skills

You will need to learn what sources are available and how to use them. The easiest way to begin this process is to **attend the Science and Engineering Library orientations** for 401 students that are held at the beginning of each semester. The library orientation will introduce you to the concepts and sources that are most essential for searching effectively. Appendix C, "Reference Searching" and the Science and Engineering Library's "Subject Guides to Science and Engineering Topics," which can be accessed at <http://www.lib.virginia.edu/science/guides/>, provide supplemental details and serve as

references. You may also wish to consult Appendix D, "Using the Internet for Research," to get a quick overview of how to proceed with an internet search.

One crucial step is to choose keywords for your search. Develop as many synonyms as possible that are related to your search topic. To search successfully, though, you may need to use the controlled vocabulary of each database you are searching. You will also need to understand some special concepts.

For example, you must understand that most databases have *two* computer-searchable indices, a *keyword* index and a *controlled-vocabulary index*. The keyword index contains many more terms than the controlled-vocabulary index, but searching the keyword index creates the problem of high proportions of false drops (irrelevant items). Searching using controlled vocabulary greatly increases the precision of a search but at the risk of omitting relevant documents. As a result, the search's recall, or ability to retrieve all or most of the relevant items, suffers. You can exploit this tradeoff by using controlled vocabulary to focus on material that is almost certain to be relevant to your search interests and using keyword searching to cast your net wider.

III. Prepare for critical analysis.

You must understand:

- The distinction between primary, secondary, and tertiary sources
- The difference between scholarly and unscholarly sources
- How to analyze a given source critically
- The tradeoff between currency and quality

Critical analysis is particularly important when it comes to evaluating Web pages, which typically do not go through independent refereeing or other editorial scrutiny. Read the page and evaluate it as you would a print source if you found it, not in a university library, but on a bench at a bus stop. Make sure it's a reliable source before you embarrass yourself by citing it or waste time by studying it. A quick litmus test is to ask the following questions:

- **Who created the page?** Is the creator identified? Does the page contain working contact information? Is the creator an expert? Does the creator seem reliable? Learn to recognize the distinctions between unsubstantiated and well-documented opinions. Determine whether the creator is a major stakeholder with regard to the subject and the extent to which the creator's judgment can be viewed as objective or independent.
- **Who is sponsoring the page and what is its purpose?** To sell you a product? To convince you of something? To promote a research group? Use critical thinking skills to evaluate the motivation and potential persuasive tactics behind the page.
- **How up-to-date and permanent is the page?** There is standard footer information on web pages that will help answer this question.

IV. Begin formulating answers to key questions

This involves extensive reading and note taking. Test your progress by formulating answers to the key questions identified at the beginning of the section. As your knowledge develops, you will begin to formulate questions of your own and begin to use increasingly more sophisticated sources. In addition to taking detailed notes, you can begin creating a preliminary list of references and thinking about how you will use sources in your proposal and in your thesis. The sections of this manual that refer specifically to those documents provide additional details about how to use and cite sources. Most importantly, you should think about how you will use what you learn in completing your project.

V. Proceed to More Specialized Sources as Necessary

At this stage, you will likely find it useful to **identify and explore the specialized databases** relevant to your subject, along with Internet-accessible sources. The knowledge you have gained through the earlier steps of this process should put you in a better position both to identify sources that are likely to be useful and to think critically about the sources you do find. The Science and Engineering Library's "Subject Guides to Science and Engineering Topics" and a number of the sources mentioned already can help you identify specialized sources, but you will probably need to get assistance from a librarian at this stage. Students may stop by, call (924-3628), or e-mail (library@virginia.edu) the Science and Engineering Library information desk. Students may also schedule a personalized research tutorial with a librarian by completing the form at <http://www.lib.virginia.edu/tutorial.html>.

One Final Note

Don't forget about **other people working in the field** as possible sources of information. Contact people involved in your area of research. Consider using the *Web of Science* (available at the Science and Engineering Library) to see which investigators are cited most and may be worth contacting. You might also join a listserve or discussion group in your subject area. Taking this step allows you to **join the critical conversation** rather than simply listening in on it. This step can also lead to major career opportunities. If you need help locating contact information for an expert in your field, please ask a librarian for help.

Sample Literature Reviews

The following literature review samples are strong because they are reader-oriented, not writer-oriented. That is, each of these samples is intended to help the reader understand the background for the thesis. The writers organized their material conceptually, in a sense creating a tutorial for the reader not familiar with the theoretical and historical literature supporting the thesis work. Specifically, each of these samples focuses on the reader's need to obtain information by:

- citing sources
- reviewing past approaches to the problem addressed in the thesis
- analyzing the theoretical basis for the thesis
- identifying the original research problem/question and how various achievements altered that problem/question
- emphasizing ground-breaking work
- clarifying how one researcher's work influenced another work
- noting the difference between single papers and extensive bodies of literature that may support claims

As you examine these samples, you should note that they also:

- demonstrate that the author has a good knowledge of the subject and the literature on it
- give a sense of the chronological development of knowledge in the field
- offer answers to the questions posed in the discussion of the aims of the review of literature that appeared earlier in this manual, **but**
- **are not** organized as a series of answers to those questions; rather they are organized either as a single narrative or according to the broad categories into which the literature related to the project falls
- place much more emphasis on ideas than they do on particular publications
- cite a variety of sources and important figures in the field
- begin with a brief introduction and conclude with a summary that ties everything together and suggests how the past work leads directly to the student's proposal, noting the cutting edge of research

Review of Technical Literature – Sample 1

Causality in distributed systems has long been a source of significant complications. As this proposal has already demonstrated, isotach networks have the potential to eliminate these complications in a low cost and highly scalable manner This section of the proposal briefly reviews past approaches and examines the theoretical basis from which isotach networks developed. It should allow the reader to better understand the historical and theoretical basis for the project. The literature on fault tolerance in isotach distributed systems falls into two broad categories: (1) causality in distributed systems and (2) fault tolerant distributed systems.

Addressing Causality in Distributed Systems

Regardless of the performance of a single serial processor, multiple processors working on the same task will theoretically be faster [3]. Distributed systems programmers have long desired to capitalize on this fundamental principle, yet many characteristics of distributed systems make achieving this goal difficult. Single processor machines make the basic guarantee that instructions will be executed in sequential order. Distributed systems, however, have no inherent linear execution of instructions. Therefore, the notion of causality, that one event happens before another, has long been a primary focus of distributed system researchers. Causality can aid in preventing deadlock, creating distributed atomic operations, and keeping consistent shared memory [11].

Originally, designers could choose a completely synchronous system in order to simplify the question of causality. In synchronous operation, the designer can make assumptions concerning process execution speeds and message delivery times. This allows for a very controlled environment in which causality is a much simpler problem. Although useful, strictly synchronous systems cannot solve many problems. An asynchronous system avoids making timing assumptions and thus operations are arbitrarily interleaved with no ordering guarantees at all [16]. Early attempts to provide some basic synchronization to asynchronous systems used locks and events to try to control causal relationships. Locks allow a single processor to gain mutually exclusive access to a block of code and data. Events allow one processor to notify another processor that it can continue a specific operation. Locks and events limit the advantages gained through parallelism by reducing the amount of work that can be executed concurrently [5, 16].

The ground breaking work of Lamport attacked this problem from a unique direction. Lamport's 1978 paper, "Time, Clocks, and the Ordering of Events in a Distributed System" formed the foundation for the concept of logical time, a method for achieving the "happened before" relation without global or physical clocks [8]. "Partially ordered logical clocks can provide a decentralized definition of time for distributed computing systems, which lack a common time base" and can be implemented in various ways [4:28]. Lamport suggests a scalar implementation, while later researchers examined vector and matrix implementations to store additional logical time information at the cost of increased overhead to maintain the more complex clocks. Raynal and

Singhal provide an overview on implementing logical time through these various means [11].

A wide array of research developed from Lamport's work. Awerbuch investigated using a synchronizer to simulate synchronicity on asynchronous networks [2]. Awerbuch's alpha-synchronizers require each node to notify its neighbors in a new pulse once it has determined that it is 'safe.' A node is 'safe' once it has received notification from all of its neighbors concerning the previous pulse. Awerbuch's alpha-synchronizers and Ranade's later work examining controlled concurrent operations contributed to the development of isotach networks [13].

Reynolds and Williams introduced isotach networks in the 1990's at the University of Virginia. This new class of networks achieves isochronicity and sequential consistency by logically relating the message travel time to the message travel distance [16]. This original concept was further developed in a paper published by Reynolds, Williams, and Wagner in 1997 [13]. This paper is the pioneering work on isotach networks and, in addition to a general description; it proposes a possible implementation and discusses preliminary performance analysis. The performance analysis demonstrated the increased efficiency of isotach networks over conventional concurrency control techniques. The researchers recognized the controversy concerning the potential overhead involved in implementing isotach logical time. They claim that "the guarantees [isotach networks] offer can be implemented cheaply yet are sufficiently powerful to enforce fundamental synchronization properties" [13:347]. The search for a low overhead implementation is a driving factor in the recent desire to implement the isotach algorithm in hardware.

The original implementation proposed in 1997 required isotach specific switches that could buffer messages and send messages to the next switch at the appropriate logical times. The initial prototype, however, was to be implemented using commercial hardware, and therefore this implementation could not be realized. Instead a new implementation was proposed in the internal working paper, "Design of the Isotach Prototype" [15]. This working paper outlines an implementation that uses token managers (TMs) and switch interface units (SIUs). TMs handle the tokens that keep track of logical time, and are similar to Awerbuch's pulses [2]. These tokens are passed from switch to switch and synchronize isotach logical time. SIUs reside between the network and the host. Messages are sent asynchronously from a host to the receiving host's SIU. The message is then buffered in the SIU until the proper logical time, at which time the message is delivered to the host. The hosts, therefore, do not see logical time, although there are mechanisms to partially or fully bring the hosts within logical time [15].

The design specification has currently been implemented both in software and in hardware by a team of computer science and electrical engineering graduate students. Both implementations have unique advantages. The software implementation offers rapid prototyping and convenient flexibility while the hardware implementation should

drastically improve the overall performance of the network[1]. Regehr's technical report provides the primary reference for the software implementation [12], while Kuebert's master's thesis is the main documentation for the hardware implementation of the TM [7]. Both of these implementations assume a fault free network, and although they address the issue of temporarily lost tokens, the implementations do not handle failed isotach devices. The thesis project proposed here allows a TM to handle failed isotach devices.

Fault Tolerant Distributed Systems

Fault tolerance and distribution share a symbiotic relationship. David Powell notes that "dependability is an inherent concern of distribution," and thus, "distribution can be a motivation for fault-tolerance." However, Powell also states that the need for redundancy to achieve fault tolerance implies that "fault-tolerance can be a motivation for distribution" [10:199]. Schneider goes further and states that "Protocols and system architectures that are not fault tolerant simply are not very useful" [14:199]. Fault tolerance of distributed systems involves a wide variety of failure modes and there is significant debate over the best failure model. Some traditional models include failstop, crash, and send omission [14].

There is a large body of research addressing the theory of fault tolerant distributed systems. A review of the relevant concepts involved can be found in Hadzilacos and Toueg's paper "Fault-Tolerance Broadcasts and Related Problems" [6]. Both authors have done significant work with distributed fault tolerance. Their paper notes that in synchronous or approximately synchronous systems, such as isotach networks, one can use message timeouts to detect failures. Such methods required bounded message transmissions and therefore make critical assumptions on the underlying hardware's performance. Great care must be taken when choosing timeout intervals.

The Delta-4 project offers an excellent practical example of distributed fault tolerance [10]. The project uses two part components to create failstop nodes. The Network Attachment Controller (NAC), similar to isotach's SIU, acts as a barrier between the actual node and the network. If the NAC determines that its node has failed, it can cease the communication between the node and the network and then notify the other nodes. This creates a failstop failure mode. The project also considered using "artificial, minimum frequency [network] traffic that spans all nodes." Such artificial traffic would allow nodes to detect failures even if there is no normal network traffic. This simulated traffic is implemented in isotach through lightweight tokens.

A recent grant extension from DARPA has allowed the isotach research group to further investigate fault tolerant isotach networks [18]. The statement of work outlines the basic strategy for this research and states the main failure modes to be considered: message loss or corruption, failures of hosts or network components, and receive-omission failures due to buffer overflows. The fundamental assumption when addressing

[1] The Hardware implementation is currently being functionally tested. Performance analysis will begin in the near future.

these concerns is a robust token exchange mechanism. Williams states, “Our approach in the proposed work is to make the token mechanism itself robust and to then use the token mechanism as a fast failure detector and as a mechanism for the fast and reliable delivery of critical signals” [18:1].

The “Fault Tolerant Isotach Systems Working Paper,” which was written by my technical advisor and the doctoral student, with whom I am working, outlines preliminary approaches to achieving these goals [17]. This internal paper reviews the lost token algorithm, the consensus and commits problems, timeout fault detection, and using layered logical time. It also provides some preliminary discussion of the logical dead space problem. My thesis project will implement some of the approaches mentioned in this internal paper by making three specific modifications that will provide a mechanism for TMs to addressed failed network devices. My project will also expand the theoretical basis for the logical dead pace problem and explains how the three modifications can address the problem.

Review of Technical Literature – Sample 2

Scientific literature has noted the study of equilibrium in thermodynamic systems for a long time. The prediction and description of the equilibrium states for any given system are problems of central importance in science. With development of the first and second law of thermodynamics, calculating equilibrium profiles for various systems has become possible.

One of the early leading figures in the subject of thermodynamics was Josiah Willard Gibbs, a famous American scientist of the 19th century. His important 1873 papers were "Graphical Methods in the Thermodynamics of Fluids" and "A Method of Geometrical Representation of the Thermodynamic Properties of Substances by Means of Surfaces" [1]. The first paper describes various thermodynamic diagrams, which have important applications in the study of the steam engine. The second paper extends these diagrams into three dimensions. In 1876, he published the first part of his most famous "On the Equilibrium of Heterogeneous Substances" [1]. The second part of this paper was published in 1879. His study in this paper incorporated chemical, elastic, surface, electromagnetic, and electrochemical phenomena into a single thermodynamic system. He also introduces the Gibbs' phase rule that describes the possible number of degrees of freedom in a (closed) system at equilibrium, in terms of the number of separate phases and the number of chemical constituents in the system. The application of these ideas led to a better understanding of chemical equilibrium in systems composed of several phases.

Building on Gibbs' work, John W. Cahn and John E. Hilliard developed the foundation of the diffuse interface theory and the Cahn-Hilliard equation in two most famous papers, known as Cahn-Hilliard I [2] and III [3]. The diffuse interface theory is used to deduce the properties of a critical nucleus. This theory constitutes an essential part of the research being undertaken for this project.

In Cahn-Hilliard I, published in 1957 and titled, "Free Energy of a Nonuniform System I: Interfacial Free Energy," the authors express the free energy density of a binary system as a function of both the concentration and the spatial derivatives of the concentration that is considered as independent variables [2]. They apply this equation to an equilibrium system with a mean concentration inside the miscibility gap. The calculus of variations is applied to find a formal expression for the equilibrium composition profile that minimizes the free energy under a specific condition. In 1959, Cahn and Hilliard published the Cahn-Hilliard III paper, "Free Energy of a Nonuniform System I: Nucleation in a Two-Component Incompressible Fluid." In this work, they study the properties of a critical nucleus using the theory they established in Cahn-Hilliard I paper and apply this theory to several and limiting cases [3].

Two important papers, predating Cahn-Hilliard I, developed theories that are fundamentally similar to that developed in Cahn-Hilliard I. The first one was the 1893 paper of van der Waals who developed a continuum thermodynamic gradient theory for fluid/fluid interface [4]. The second one was the paper of Ginsburg and Landau who developed a phenomenological theory of type II superconductors in 1950 [4]. However,

these two theories do not properly account for the contributions of fluctuations to the equilibrium state.

The paper entitled “Phase Changes in a Thin Plate with Non-Local Self-Stress-Effect,” written in 1991 by John W. Cahn and F. C. Larche, further extends the study of thermodynamic equilibrium to a thin-plate system [5]. A theory of diffusion and equilibrium in a thin plate is developed in this paper. The theory is based on a free energy that depends on composition, its gradients, and strains. Under certain assumptions, a standard diffusion equation is derived. More importantly, Cahn and Larche derived a mathematical expression to describe two-phase equilibrium. However, they did not solve the equation to obtain any equilibrium composition profiles.

Although many famous scientists have already derived mathematical expressions to describe equilibrium composition of a binary system, these mathematical equations can only be used in certain cases. Furthermore, some of these equations are not solved analytically or numerically. This thesis project aims to predict one-dimensional equilibrium composition profile for broader cases. It also examines the effect of compositional strains on the equilibrium composition profiles.

APPENDIX C: REFERENCE SEARCHING

Basic Search Procedures and Syntax

Questions that are difficult or impossible to answer using printed indexes are easily answered through online searching. To maximize the timesaving potential of online searching, you need to **proceed in a disciplined way**. Therefore, your search procedure checklist should look like this:

1. Identify the search topic
2. Separate the concepts if there is more than one
3. Think of other words for the concepts
4. Connect the concepts
5. Consider variations in spelling and word endings
6. Perform the search
7. Evaluate and modify the search
8. Read, print, or display the search result

Each database you search has its own **search syntax**. Some of the following search tools will be available in any given database, while others will not. This point may not be made clear when you start working with the database, so consult the help screens to learn what is available in each database.

You need to understand and know how to use:

Boolean operators (AND, OR, NOT) may not be implemented in databases that use inclusion/exclusion operators. You can use Boolean operators in VIRGO.

Capitalization may restrict the search.

Inclusion/Exclusion operators (+,-) are common in Web search engines. Inclusion (+) requires term for retrieval; exclusion (-) rejects term.

Nesting is typically implemented with parentheses, and enables finely-tuned searches, such as the following:

(Potomac or Rappahannock) and (history and geography)
(Potomac and Rappahannock) and sailing
(Potomac and Rappahannock) not tourism

Phrase searching restricts search to match phrase (usually implemented with "quotation marks like this").

Proximity operators may be available (check advanced search syntax page).

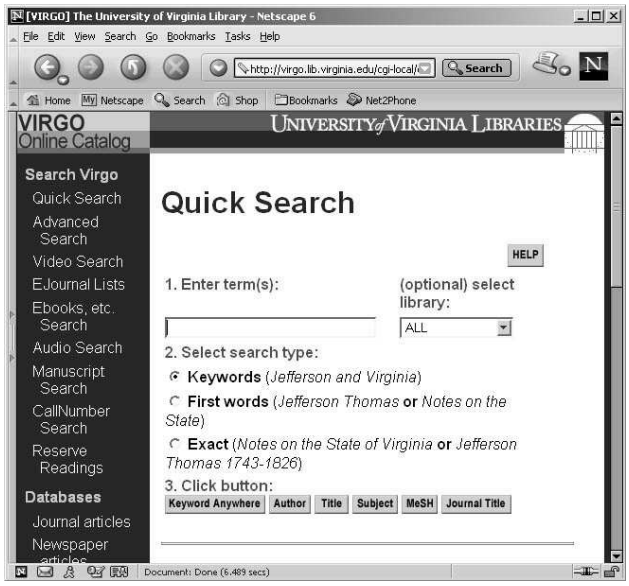
Stop words may cause your search to fail if you search using one. VIRGO's stop word list: a, an, as, at, be, but, by, do, for, if, in, is, it, of, on, the, to.

Truncation (also called wildcard) is implemented in VIRGO using the dollar sign ($).

USING VIRGO

VIRGO is the University of Virginia Library's computerized catalog. It also functions as a gateway to numerous databases. All current University of Virginia students, faculty, and staff can access Library databases from on-grounds and off-grounds through Internet Service Providers such as Cornerstone or AOL. To access these resources from off-grounds, you must use a proxy server account (instructions are available from ITC at: <http://www.itc.virginia.edu/desktop/proxy>), UVA-Anywhere (information available at <http://www.itc.virginia.edu/desktop/pki/vpn/usage.phtml>), or UVAAnywhere-Lite WebVPN (<http://www.itc.virginia.edu/vpn/webvpn/>). These services are free to members of the University community.

Online searching is a fast, efficient way to gather information from computerized databases. Compiled by different producers, these databases contain specialized information in a variety of subjects. The databases are, in general, electronic continuations of printed sources.



Locating Undergraduate Theses in Virgo

All fourth-year engineering theses from 1983 to the present are included in VIRGO. While these records are not as detailed as some in VIRGO, they are accessible in all the standard ways **except** for *subject* searches.

The easiest way to search for a thesis using the **basic VIRGO search capabilities is to do an author or title search**. Note that you may search by last name only, or last name and first initial, if you are unsure of the person's full name. Even a portion of the last name or the title of the thesis will do, if you are unsure of how to spell the full last name or of the full title.

The following instructions outline the most basic ways to proceed. For more information, click the HELP button or read "Quick Tips" at the bottom of the screen.

Searching by author:

1. Enter the author's name (last name first) in the search box.
2. Select "begins with" search type
3. Click the "author" button

Searching by title:

1. Enter the thesis title in the search box
2. Select "begins with" search type
3. Click the "title" button

If you do not have exact information about the title or author, **VIRGO's keyword search** provides you with a powerful means of searching. The computer indexes all the significant words in each VIRGO entry. You may search by any one (or combination) of them to retrieve records on a specific topic of interest. It is important to note that you should use single quotation marks to search for phrases in VIRGO.

Searching by keyword:

1. Type the keyword of interest in the search box
2. Click on the "keyword anywhere" button

Another useful application of the keyword search is to retrieve all of the fourth-year theses done in **a particular department**. (You can use this same search procedure to retrieve dissertations and masters theses as well.) To do this kind of search:

1. Type the following in the search box:
   'Civil engineering' AND 'thesis'
2. Click on the "keyword anywhere" button

The appropriate departmental keywords are:

AEROSPACE ENGINEERING	ELECTRICAL ENGINEERING
APPLIED MATHEMATICS	ENGINEERING SCIENCE
BIOMEDICAL ENGINEERING	MATERIAL SCIENCE
CHEMICAL ENGINEERING	MECHANICAL ENGINEERING
CIVIL ENGINEERING	NUCLEAR ENGINEERING
COMPUTER SCIENCE	SYSTEMS ENGINEERING

You may further **qualify your search by year**, if you wish. To qualify by year, click the "advanced search" tab in the upper left of the search screen, type your keyword in the "keyword anywhere" field, type the year of interest in the "publication year" box, and click the "search" button. Theses from 1990 to the present are located in the Science and Engineering Library, at the end of the alphabet on the book floor (two floors down).

If you only want to search fourth-year theses, you can limit your search in the **advanced search mode.**

Searching fourth-year theses only:

1. Click the "advanced search" tab in the upper left of the search screen
2. Type a keyword you wish to search in the "keyword anywhere" search box
3. Scroll down to the search limit and choose "Thesis-4th" from the pull-down menu for item type. (Hint: If you click on the arrow for the pull-down menu and type the letter T it will automatically jump to T in this rather long list of item types.)
4. Click on the "search" button

For theses prior to 1983:

The library maintains a printed list of fourth-year theses done prior to 1983. Ask at the Information Desk for help locating these theses.

Theses up to 1993 are housed in the Library's Ivy Stacks storage facility. To request them from IVY, use the "request item" button in VIRGO, or ask for assistance at the Library.

Selected Engineering and Applied Science Reference Works

The following material describes the different types of reference works, gives specific examples of each type (including call numbers), and offers advice on how to find each type in VIRGO. The items mentioned in this manual are merely examples – **do not** limit your research to the resources listed here.

Finding Reference Works on your Topic

To identify reference works specific to your topic, you can do the following search in VIRGO <http://virgo.lib.virginia.edu/>.

Choose:	Advanced Search
Type:	your subject (in the "keyword anywhere" field)
Choose:	SCI-ENG (from the pull down menu for "library")
Choose:	REFERENCE (from the pull down menu for "item type")
Click:	Search button

DICTIONARIES

In addition to general dictionaries of English and foreign languages, there are also numerous special and subject dictionaries. Consult these special dictionaries when you encounter new terminology in your advanced research.

To find specialized dictionaries in VIRGO:

Type:	your subject AND dictionar$
Click:	"keyword anywhere" search button

Some examples of useful specialized dictionaries include:

The McGraw-Hill Dictionary of Scientific and Technical Terms
Q 123 .M34 1994 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF

Acronyms, Initialisms, & Abbreviations dictionary
PE1693 .G3 1992 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF

The Comprehensive Dictionary of Electrical Engineering
TK9 .C575 1999 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF

Encyclopedic Dictionary of Named Processes in Chemical Technology
TP155.7 .C664 1999 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF

The Illustrated Dictionary of Metalworking and Manufacturing Technology
TS204 .I36 1999 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF

SAE Dictionary of Aerospace Engineering
TL509 .S24 1998 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF

ENCYCLOPEDIAS

An encyclopedia is the product of efforts to gather together information either from all branches of knowledge or from a single subject area and arrange it in alphabetical order for easy reference. Like dictionaries, encyclopedias can be general or subject specific. Encyclopedia entries will provide you with a concise overview of a concept and often refer you to additional resources.

To find specialized encyclopedias in VIRGO:

Type:	your subject AND encyclop$
Click:	"keyword anywhere" search button

Some examples of useful encyclopedias include:

Encyclopedia Britannica
AE5 .E363 1998 REFERENCE AL-REF
Or Britannica Online (electronic version on the Library web)

Encyclopedia of Chemical Technology ("Kirk-Othmer")
TP 9.E685 1991 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF
Or electronic version available on the Library web

Encyclopedia of Bioprocess Technology: Fermentation, Biocatalysis, and Bioseparation
TP248.3 .F57 1999 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF

Van Nostrand's Scientific Encyclopedia
Q 121 .V3 2002 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF

Concise Encyclopedia of Measurement & Instrumentation
TA 165 .C62 1994 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF

INTERNET LIBRARY WEB

The UVA Library has created a series of subject guides for each department in the Engineering School. To search these selected web sites, go to: <http://www.lib.virginia.edu/science/guides/>. For more general web resources, try: <http://www.lib.virginia.edu/reference/ >.

HANDBOOKS

Handbooks are quick reference guides to a particular field of knowledge. They generally assume subject expertise on the part of the user. Handbooks contain tables, graphs, charts and equations that are useful to subject experts.

To find handbooks in VIRGO:

Type:	your subject AND handbook
Click:	"keyword anywhere" search button

Some examples of useful handbooks include:

Handbook of Electrical Engineering Calculations
TS168 .H36 1999 SCIENCE AND ENGINEERING LIBRARY-STKS

Handbook of Communications Systems Management
TK5101 .H283 1999 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF

Formula Handbook for Environmental Engineers and Scientists
TD153 .B58 1998 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF

Highway Design and Traffic Safety Engineering Handbook
TE175 .L36 1999 SCIENCE AND ENGINEERING LIBRARY-STKS

STATISTICS

To locate statistics on a particular topic, it will be useful to consult an index to statistical sources. Examples of these indexes include:

American Statistics Index
Index to statistical publications of the U.S. Government.
Z 7554 .U5 A46 REFERENCE ALD DOC-READRM

Statistical Reference Index
Index to selected statistics of non-Federal government sources.
Z7553 .S73 1998 DOC-NC ALD DOC-READRM

Statistical Universe
Electronic database which includes the two indexes above.
INTERNET LIBRARYWEB

BOOKS AND MONOGRAPHS

VIRGO will tell you about books and other monographs (conference proceedings, technical reports, theses and dissertations) which are held in UVa libraries. To learn about books that may be available elsewhere, try:

WorldCat
Electronic database of library catalogs from around the world.
INTERNET LIBRARYWEB

Books in Print
Electronic database of books currently in print.
INTERNET LIBRARYWEB

Amazon.com
Online bookseller with subject searching of their database.
INTERNET www.amazon.com

PATENTS

To locate patents related to your topic consult the search services located on the libraries' Patent and Trademark Information guide at <http://www.lib.virginia.edu/science/guides/s-patent.htm>. While UVA does not collect all patents, the libraries can obtain patents you need via Interlibrary Loan.

STANDARDS

There are many useful finding aids to locate scientific and technical standards on the libraries' Sources for Scientific Standards guide at <http://www.lib.virginia.edu/science/guides/s-stand.htm>. While UVA does not collect all standards, the libraries can obtain standards you need via Interlibrary Loan.

Annual Book of ASTM Standards
TA 401 .A653 REFERENCE SCIENCE AND ENGINEERING
LIBRARY-REF

TECHNICAL REPORTS

Technical reports are often difficult to identify and locate because they have limited publication. The National Technical Information Service produces a database (NTIS), which indexes technical reports covering a wide spectrum of interests produced by local, state, and federal government agencies, as well as by individuals, private and for-profit groups. For more information on technical reports, ask a Library or consult the Library's Technical Reports Guide Page at <http://www.lib.virginia.edu/science/guides/s-tchrpt.htm>.

National Technical Information Service
INTERNET LIBRARYWEB

INDEXES AND ABSTRACTS

Indexes and abstracts are paper or electronic publications that allow researchers to search by topic and retrieve citations to relevant publications. Older indexes tend to be in paper, although many migrated to electronic databases in the 1980s and 1990s.

The following indexes are a sample of the hundreds of indexes available through the UVA libraries. Please consult a librarian to help you identify which resources will be the most productive for your research topic.

A complete listing can be found on the Science & Engineering Libraries "Databases" page at: <http://www.lib.virginia.edu/science/dbases/ >.

Aerospace Engineering

Aerospace and High Technology Database

- 1986 to present
- provides coverage of basic and applied research in aeronautics, astronautics, and space sciences.
- also covers technology development and applications in complementary and supporting fields such as chemistry, geosciences, physics, communications, and electronics.
- includes journal literature, reports issued by NASA, other U.S. government agencies, international institutions, universities, and private firms.

EiCompendex

- covers all fields of engineering
- 1980 to present on-line; print version (Engineering Index) goes back to 1906
- includes journal articles conference papers, web sites
- technical and research level materials
- abstracts available

Mechanical & Transportation Engineering Abstracts (CSA)

- covers mechanical and transportation engineering and their complementary fields
- provides coverage of the international engineering literature
- monitors over 2,600 serial titles as well as numerous non-serial publications

Scientific and Technical Aerospace Reports (STAR)

- lists citations and abstracts of NASA and worldwide aerospace-related research
- 1996 to present online; updated bi-weekly

Web of Science

- unique multidisciplinary index featuring citation indexing, which permits searching by cited references in articles from over 5,700 science and engineering journals. Online version of the *Science Citation Index*.
- includes links to full-text articles, where available
- 1981 to present. The print version of *Science Citation Index* goes back to 1955
- includes abstracts
- updated weekly

Applied Mathematics

EiCompendex

- covers all fields of engineering
- 1980 to present on-line; print version (Engineering Index) goes back to 1906
- includes journal articles conference papers, web sites
- technical and research level materials
- abstracts available

MathSciNet

- covers Mathematical Reviews from 1940 to the present

Biomedical Engineering

Biotechnology and Bioengineering Abstracts

- covers research, applications, regulatory developments and new patents across all areas of biotechnology and bioengineering, including medical, pharmaceutical, agricultural, environmental and marine biology
- 1982 - present
- technical and research level materials

EiCompendex

- covers all fields of engineering
- 1980 to present on-line; print version (Engineering Index) goes back to 1906
- includes journal articles conference papers, web sites
- technical and research level materials
- abstracts available

ENGnetBASE

- CRC Engineering Handbooks online

Medical and Pharmaceutical Biotechnology Abstracts (CSA)

- focuses on worldwide studies in which biotechnology, molecular biology, or genetics are applied to medicine and pharmaceuticals, human health, or the diagnosis and treatment of disease.

- 1993 to present

MEDLINE

- produced by the U.S. National Library of Medicine, this is recognized as the premier source for bibliographic and abstract coverage of biomedical literature, including allied health, biological and physical sciences, humanities and information science as they relate to medicine and health care
- includes journal articles, monographs, conference proceedings
- abstracts are available for about 67% of the records
- 1966 to present

Web of Science

- unique multidisciplinary index featuring citation indexing, which permits searching by cited references in articles from over 5,700 science and engineering journals. Online version of the *Science Citation Index*.
- includes links to full-text articles, where available
- 1981 to present. The print version of *Science Citation Index* goes back to 1955
- includes abstracts
- updated weekly

Chemical Engineering

EiCompendex

- covers all fields of engineering
- 1980 to present on-line; print version (Engineering Index) goes back to 1906
- includes journal articles conference papers, web sites
- technical and research level materials
- abstracts available

ENGnetBASE

- CRC Engineering Handbooks online

SciFinder Scholar

- premier chemistry bibliographic and reference research tool
- can be searched by research topic, substance identifier, chemical structure, chemical reaction, and/or author's name

Web of Science

- unique multidisciplinary index featuring citation indexing, which permits searching by cited references in articles from over 5,700 science and engineering journals. Online version of the *Science Citation Index*.
- includes links to full-text articles, where available
- 1981 to present. The print version of *Science Citation Index* goes back to 1955

- includes abstracts
- updated weekly

Civil Engineering

ASCE Civil Engineering Database

- covers civil engineering, widely defined
- 1972 to present
- includes all the journals, conference proceedings, books, standards, manuals, magazines, and newsletters published by ASCE. *NOTE* indexes ASCE publications ONLY.
- levels range from introductory to professional.

EiCompendex

- covers all fields of engineering
- 1980 to present on-line; print version (Engineering Index) goes back to 1906
- includes journal articles conference papers, web sites
- technical and research level materials
- abstracts available

ENGnetBASE

- CRC Engineering Handbooks online

Environmental Engineering Abstracts (CSA)

- Covers technological and engineering aspects of air and water quality, environmental safety, and energy production.
- More than 700 journals
- 1990 to present

TRIS Online (Transportation Research Information Services)

- world's largest and most comprehensive bibliographic resource on transportation information.
- Contains over 350,000 records of published and ongoing research on all modes and disciplines in the field of transportation.
- 1960 to present

Web of Science

- unique multidisciplinary index featuring citation indexing, which permits searching by cited references in articles from over 5,700 science and engineering journals. Online version of the *Science Citation Index*.
- includes links to full-text articles, where available
- 1981 to present. The print version of *Science Citation Index* goes back to 1955

- includes abstracts
- updated weekly

Computer Science

ACM Digital Library

- provides full-text of every article published by the ACM
- 1985 to present

Computer and Information Systems Abstracts (CSA)

- provides a comprehensive monthly update on the latest theoretical research and practical applications around the world
- international coverage with the monitoring of over 3,000 serial titles as well as numerous non-serial publications.
- 1981 to present

Electronics and Communications Abstracts (CSA)

- provides international coverage with the monitoring of over 3,000 serial titles as well as numerous non-serial publications for electronics and communications abstracts.
- 1981 to present

EiCompendex

- covers all fields of engineering
- 1980 to present on-line; print version (Engineering Index) goes back to 1906
- includes journal articles conference papers, web sites
- technical and research level materials
- abstracts available

ENGnetBASE

- CRC Engineering Handbooks online

IEEE Xplore Full Text

- provides full-text access to IEEE transactions, journals, magazines and conference proceedings.
- 1988 to present.

INSPEC

- covers electrical and electronics engineering, computer, control science and physics.
- 1969 to present
- includes journal articles, conference papers, books, technical reports and theses
- technical and research level materials
- includes abstracts for Science and Engineering Libraryected materials

Internet & Personal Computing Abstracts

- 100 publications are covered, including mass-market computer publications, as well as those focusing on specific topics, such as hardware platforms, operating systems (Windows, DOS, UNIX, etc.), online systems, the Internet, management, networking, and electronic publishing.
- 1989 to present

Web of Science

- unique multidisciplinary index featuring citation indexing, which permits searching by cited references in articles from over 5,700 science and engineering journals. Online version of the *Science Citation Index*.
- includes links to full-text articles, where available
- 1981 to present. The print version of *Science Citation Index* goes back to 1955
- includes abstracts
- updated weekly

Electrical Engineering

Electronics & Communications Abstracts

- provides international coverage with the monitoring of over 3,000 serial titles as well as numerous non-serial publications for electronics and communications abstracts.
- 1981 to present

EiCompendex

- covers all fields of engineering
- 1980 to present on-line; print version (Engineering Index) goes back to 1906
- includes journal articles conference papers, web sites
- technical and research level materials
- abstracts available

ENGnetBASE

- CRC Engineering Handbooks online

IEEE Xplore Full Text

- provides full-text access to IEEE transactions, journals, magazines and conference proceedings.
- 1988 to present.

INSPEC

- covers electrical and electronics engineering, computer, control science and physics.
- 1969 to present
- includes journal articles, conference papers, books, technical reports and theses

- technical and research level materials
- includes abstracts for Science and Engineering Library selected materials

Solid State and Superconductivity Abstracts

- presents global coverage on all aspects of theory, production, and application of solid state materials and devices - as well as the new high- and low-temperature superconductivity technology, now highlighted in every issue.
- provides international coverage with the monitoring of over 3,000 serial titles as well as numerous non-serial publications.
- 1981 to present

Web of Science

- unique multidisciplinary index featuring citation indexing, which permits searching by cited references in articles from over 5,700 science and engineering journals. Online version of the *Science Citation Index*.
- includes links to full-text articles, where available
- 1981 to present. The print version of *Science Citation Index* goes back to 1955
- includes abstracts
- updated weekly

General Engineering

EiCompendex

- covers all fields of engineering
- 1980 to present on-line; print version (Engineering Index) goes back to 1906
- includes journal articles conference papers, web sites
- technical and research level materials
- abstracts available

ENGnetBASE

- CRC Engineering Handbooks online

Web of Science

- unique multidisciplinary index featuring citation indexing, which permits searching by cited references in articles from over 5,700 science and engineering journals. Online version of the *Science Citation Index*.
- includes links to full-text articles, where available
- 1981 to present. The print version of *Science Citation Index* goes back to 1955
- includes abstracts
- updated weekly

Materials Science

Engineering Materials Abstracts

- an electronic database containing Ceramics, Composites and Polymers subfiles.
- 1986 to present

EiCompendex

- covers all fields of engineering
- 1980 to present on-line; print version (Engineering Index) goes back to 1906
- includes journal articles conference papers, web sites
- technical and research level materials
- abstracts available

ENGnetBASE

- CRC Engineering Handbooks online

Metadex

- comprehensive coverage of the science & practice of metallurgy and materials science
- 1966 to present
- includes journal articles, conference papers, review, technical reports and books.
- technical and research level materials
- includes abstracts

Web of Science

- unique multidisciplinary index featuring citation indexing, which permits searching by cited references in articles from over 5,700 science and engineering journals. Online version of the *Science Citation Index*.
- includes links to full-text articles, where available
- 1981 to present. The print version of *Science Citation Index* goes back to 1955
- includes abstracts
- updated weekly

Mechanical Engineering

Aerospace and High Technology Database

- 1986 to present
- provides coverage of basic and applied research in aeronautics, astronautics, and space sciences.
- also covers technology development and applications in complementary and supporting fields such as chemistry, geosciences, physics, communications, and electronics.
- includes journal literature, reports issued by NASA, other U.S. government agencies, international institutions, universities, and private firms.

EiCompendex

- covers all fields of engineering

- 1980 to present on-line; print version (Engineering Index) goes back to 1906
- includes journal articles conference papers, web sites
- technical and research level materials
- abstracts available

ENGnetBASE

- CRC Engineering Handbooks online

Mechanical & Transportation Engineering Abstracts

- covers mechanical and transportation engineering and their complementary fields
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- unique multidisciplinary index featuring citation indexing, which permits searching by cited references in articles from over 5,700 science and engineering journals. Online version of the *Science Citation Index*.
- includes links to full-text articles, where available
- 1981 to present. The print version of *Science Citation Index* goes back to 1955
- includes abstracts
- updated weekly

Systems Engineering

EiCompendex

- covers all fields of engineering
- 1980 to present on-line; print version (Engineering Index) goes back to 1906
- includes journal articles conference papers, web sites
- technical and research level materials
- abstracts available

ENGnetBASE

- CRC Engineering Handbooks online

Environmental Engineering Abstracts

- Covers technological and engineering aspects of air and water quality, environmental safety, and energy production.
- More than 700 journals
- 1990 to present

INSPEC

- Scientific and technical journals and conference proceedings in computing, electrical engineering, physics.
- Updated monthly.
- 1969 to present

Risk Abstracts

- encompasses risk arising from industrial, technological, environmental, and other sources, with an emphasis on assessment and management of risk
- multidisciplinary coverage of risk-related concerns ranges from public and environmental health to social issues and psychological aspects
- 1990 to present

TRIS Online (Transportation Research Information Services)

- world's largest and most comprehensive bibliographic resource on transportation information.
- Contains over 350,000 records of published and ongoing research on all modes and disciplines in the field of transportation.
- 1960 to present

Web of Science

- unique multidisciplinary index featuring citation indexing, which permits searching by cited references in articles from over 5,700 science and engineering journals. Online version of the *Science Citation Index*.
- includes links to full-text articles, where available
- 1981 to present. The print version of *Science Citation Index* goes back to 1955
- includes abstracts
- updated weekly

PERIODICALS

The term "periodicals" refers to magazines, journals, and other publications that are issued at regular intervals. Periodicals are good sources of current information on a topic. To locate magazines and journals that publish papers on your topic, you can search in VIRGO.

To locate a particular journal title in VIRGO:

1. Enter the journal title in the search box
2. Select "Begins with" search type
3. Click on the "Journal title" button

To locate electronic journals and full-text:

Many periodicals are available online. If a given title is available electronically, the VIRGO record will contain a URL that will link you directly to the online version. Be sure to check the years of coverage for the electronic version; many journals are available in both print and electronic form. You can also view a list of electronic journals in a given subject area by choosing the "Electronic Journals" search option in VIRGO.

The Library subscribes to many collections of e-journals; you can search these collections individually if you wish. Examples of full-text collections include:

- *ACM Digital Library*, selected publications from the Association for Computing Machinery
- *IEEE Xplore*, full-text access to transactions, journals, magazines and conference proceedings published since 1988 and all current Standards of the Institute for Electrical and Electronics Engineers (IEEE) as well as the Institution of Electrical Engineers (IEE)
- *JSTOR*, back issues of the *Philosophical Transactions of the Royal Society of London, Proceedings of the National Academy of Sciences, and Science.*
- *ScienceDirect*, full-text of journals published by Elsevier

To locate magazines and journals that publish papers on your topic:

Type:	Your subject AND periodicals
Click:	"keyword anywhere" search button

To learn about titles to which UVA may not subscribe, you can consult the following resources:

PIE, Publications Indexed for Engineering
List of journals in engineering
Z 7913 .P15 1997 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF

Chemical Abstracts Service Source Index
List of journals in chemistry, biology, engineering and the physical sciences.
Z 5523 .A52 REFERENCE SCIENCE AND ENGINEERING LIBRARY-REF

Ulrich's International Periodicals Directory
INTERNET LIBRARY WEB

APPENDIX D: USING THE INTERNET FOR RESEARCH

If you decide that the Internet is an appropriate resource for your topic, it is most important that you evaluate the quality and usefulness of particular Web Sites before using them. Be selective about any information you glean from the Web.

When you are evaluating a Web site, ask yourself the following questions:

Authority

- Is the author (*i.e*. the person or group responsible for the page's content) named?
- Are the author's credentials listed? Who sponsors the site? What is the suffix in the URL? (*.com* [commercial firm]; *.edu* [educational institution]; *.gov* [government agency]; *.net* [ISP]; *.org* [non-profit organization])
- Does the author identify the sources of her/his information? Are there references?

Purpose

- Does the author indicate why the site was created? What is the intended audience?
- Is the site instructional? Promotional? Commercial? Intended for entertainment?
- Is there advertising? Is the advertising distinct from the content of the site, or is it an integral part of the site?
- Is the author objective? Does s/he have an identifiable bias?

Accuracy

- Is the information reliable and error-free? Can you verify this information using other sources?
- Is the page edited? Are there fact-checkers?

Currency

- Can you tell when the site was first created?
- Can you tell when the information on the site was last updated?
- Does the author or creator indicate which information is newly added?

Organization & Design

- Is the site well-organized and easy to navigate?
- Do all of the links work?
- Is there a site index?
- Do the graphics load quickly?
- Are there typographical errors?

Stability

- Did you have trouble connecting to the site?
- Is the site stable? Is it likely that you will be able to find it at the same Web address tomorrow? Next week? Six months from now?

APPENDIX E: FREQUENTLY ASKED QUESTIONS ABOUT GROUP PROJECTS

- **Can I use a group project (such as Systems Capstones or Engineering in Context projects) for my senior thesis?** Yes.

- **Am I required to use those projects for my thesis?** No. You are free to choose your own topic. Both require significant time, so doing two projects might reduce the quality of both. Some unusually disciplined students have done strong work on separate projects.

- **What goals are common to the thesis and group projects?** Typically, both require you to demonstrate technical competence, professional orientation, and the ability to communicate effectively. Both are designed to help you focus, synthesize, and apply the knowledge and skills you have gained through your undergraduate curriculum. Often, both treat constraints in areas such as economics, the environment, ethics, politics, sustainability, and social considerations as integral parts of engineering problem solving and decision-making. In the typical case where a student uses the group project as the basis for the thesis, both draw on a common body of experience and expertise.

- **How do the two projects differ?** The undergraduate thesis is a school requirement (administered by STS) that stresses individual competence and independent thought and reflection. Group projects, such as capstones, often are department and accreditation requirements that stress group solutions to client problems. The most obvious distinctions between the two are apparent in the final reports that each requires. Group projects often culminate in a report written and are presented jointly by the team to the project's client. Such reports often are impersonal, written in a neutral voice, and directly addresses the specific issues and concerns of the client.

  In contrast, the undergraduate thesis culminates in a report written by the individual team member and presented by the individual to the STS class. This report maintains a professional tone but is written in the author's individual voice, emphasizing independent thought processes and unique points of view. This report may address issues and concerns apart from those of the client.

  In sum, the final reports for the two projects package your experience and expertise in different ways, each with a different focus. These differences allow you to demonstrate the ability to function in both group and

individual contexts and to maximize the value derived from the investments you make in a group project.

- **What are the roles of the technical and STS advisors in assigning grades?** The STS advisor assigns grades in STS 401/402, including on thesis assignments. In grading the proposal and final report, the STS advisor takes the technical advisor's evaluation into account. For most students involved in group projects, the project faculty advisor will also be the technical advisor. In those cases, those faculty members often assign grades for the proposal, oral presentations, and other reports produced in group courses.

- **Might I receive different grades on the thesis and the group project?** Yes.

- **If I am in a group project, what should I submit for the statement of topic assignment in STS 401?** Ideally, the name of your project and client along with a brief description of your project. If you have not been assigned to a group, you should submit a ranked list of group preferences along with the reasons for the rankings.

- **In the opening weeks of the semester, what should I do to advance my group and thesis projects while I await meetings with and direction from my client or advisor?** Although in a group, you bear individual responsibility for your thesis. While you are waiting for meetings to be held or for direction from your client and advisor, it is possible to make significant progress in doing background research. Before meeting with your client, you should have researched your client, the industry in which the client is involved, and the topic areas associated with your project. You should also familiarize yourself with the strategies used and problems encountered by previous groups. Groups should take collective responsibility for the leadership of the project at every stage of its development.

  Put another way, the thesis is *your* project, not your group's project. Do not allow anyone else—clients or group members—to slow your progress on the thesis. The group project is a base for your thesis, not its limit.

- **In my proposal, should I introduce the overall group project (its goals, client, members, and advisor) as well as discussing my own specific projects or responsibilities within the group?** Yes.

- **In the proposal describing my thesis project, must I take responsibility for particular topics within the overall capstone project?** No, though it is acceptable to do so. You may propose the group project as a whole. As your project evolves and your group moves through the problem definition process that will occupy most of the first semester for some groups, you should be alert to possible areas of focus for your undergraduate thesis. The thesis requires independent thought, reflection, and writing; it does not require you to do independent technical work or to define some aspect of the project as belonging to you alone. You should recognize that it is a hard requirement to define a distinctive focus for the thesis by the time you submit the progress report at the beginning of STS 402.

- **In thesis documents (proposal, report, etc.) may I use jointly authored material originally produced for or by my group?** Yes, so long as you credit the sources(s); however, you should avoid extensive direct quotations and take advantage of the opportunity to improve your own grasp of the capstone by articulating your own descriptions of the context, concepts, and challenges of the project. Selected group documents may be used in an appendix to the thesis, provided these appendices do not substitute for a thorough discussion of important points in the text. Portions of individual theses may be used in the final group report. The thesis and the group project overlap, but each requires work the other does not. Viewed and managed properly, the two projects add value to each other.

- **By the beginning of STS 402, should I have a defined an area of primary responsibility within the group?** It is up to the groups and their advisors to determine how and when responsibility will be allocated within the group. What is essential for the undergraduate thesis, however, is for each student to define a distinctive focus for his or her technical report by the time the progress report is submitted in STS 402. Defining the distinctive focus for the thesis is easiest when the group members have defined an area of responsibility for each group member. In circumstances where the group does not find it desirable to allocate individual responsibility within the group, students may create an individual focus for the thesis in one of three ways: (1) use the project as a whole and the group's experience with it as a case study in some important issue; (2) select an aspect of the work, perhaps a technique used to solve a problem, to explore in more depth through extended examination of the literature or testing; or (3) identify a related topic or possible extension of the group's work that was not explored extensively by the group but whose significance was revealed through the group's work.

APPENDIX F: GANTT CHART

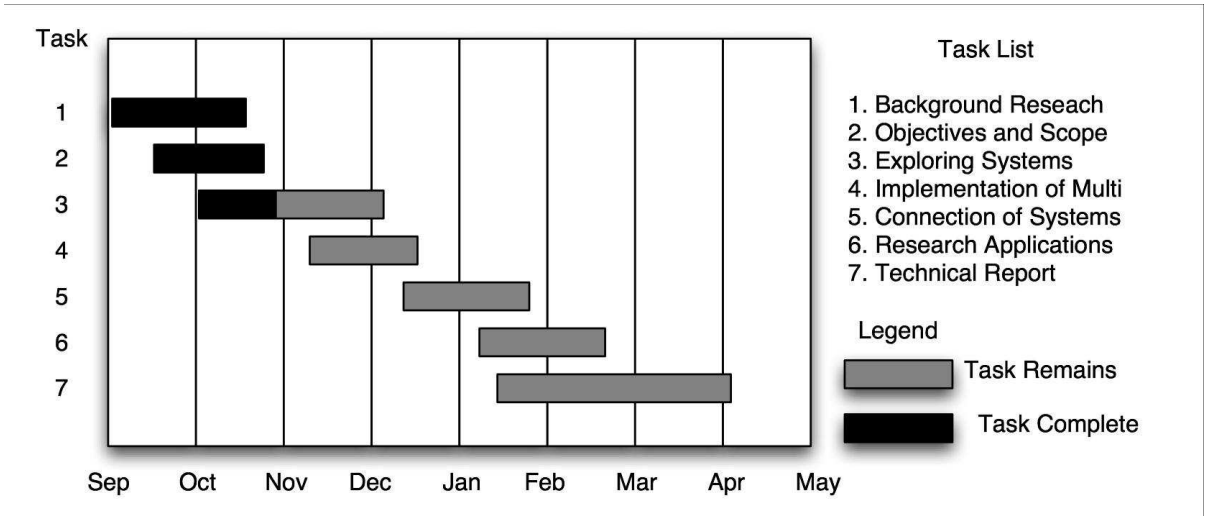
A Gantt chart is one of the most commonly used formats for visual representation of the schedule for your project. The sample chart reproduced below provides a minimal amount of detail. You may want to include more. The minimal criteria for good Gantt Charts are:

1. They divide the work involved in the project into **a sequence of numbered steps**. (Letters could also be used to order the steps.)

2. They **look reasonably professional**.

3. They **emphasize the technical work** involved in the project but also **include the various documents and reports** created for STS 401/402.

Sample Schedule



You can create a Gantt chart in Microsoft Excel.

APPENDIX G: PREPARING GRAPHICS

Either create your own diagrams and tables or take them from published sources. (See the section below for details on citing the sources of graphics.) Because a diagram or table from another publication may include material not relevant to your thesis, it is generally preferable that you create graphics appropriate for your report. With the availability of a number of graphic software packages (such as graphing spreadsheets, word processor table functions, Visio, Photoshop, and GIMP), you should make a reasonable effort to create diagrams and tables suited to your report and not simply duplicate visual materials from other sources.

When creating graphic materials on the computer, you should take full advantage of the software's features and experiment with various ways to present your image or data. You may wish to try arranging the material vertically or horizontally, using different shading, and so forth. Make certain that each feature (shading, arrows, and such) conveys information that the reader needs to know. A good rule of thumb is not to add any features to a table or diagram that you do not discuss in the text. You should be careful not to employ too many different typefaces and formats; frequently, the use of italics, underlining, boldface, and numerous fonts makes a simple diagram too confusing. Like flowery adjectives in the text, excessively ornate graphics may make the reader skeptical of your professional ability. Keep in mind that simplicity is a virtue but amateurism is not.

You should scan any hand-prepared graphics into a digital format if they will have a final size at single-page or smaller in the thesis. Multi-page hand-drawn graphics may be inserted directly as described in the "Placing Graphics" subsection below. If you prepare graphics by hand, use pen and ink or black ballpoint. When necessary, hand-drawn lettering in graphics should be done in block letters, not script, using all capitals (all the same size). Typed labels, or labels inserted by graphics software after the graphic is scanned, are better.

Numbers, Titles, and Captions on Graphics

All illustrations should be given a figure number ("Figure 1," "Figure 2," etc.), title, and a short, descriptive caption (typically 2-3 sentences). Identifying an illustration as "Figure 1" permits the reader to move easily from the text to the graphic, so be sure to provide references in the text whenever the reader should consult the illustration. Be sure to include a key to any lettered components or shaded areas on the graphic and to clearly label significant parts on the figure itself.

Citing Sources for Graphics

Cite sources for all graphics using the same citation system used elsewhere in your document. If you are using the in-text citation system, you cite the source at the end of the caption, just as you would acknowledge a source at the end of a sentence.

Figure 1. Projected U.S. energy needs, 2000-2020 [Howard 1999: 46]. These numbers are significantly higher than studies done in the 1970s had projected.

If a graphic is adapted from another source, use a phrase such as "Adapted from" as in [Adapted from Howard 1999:46]. If a graphic is a group product (common in capstones and some other projects), cite the team name or the names of the individuals as the source.

If you create a graphic, include the phrase "Created by Author" as in [Created by Author].

Placing Graphics

If you want the reader to examine your diagrams and tables while reading your text, you must make them as easy as possible to find. While it is more convenient for the writer to place all graphic materials at the end of the report, this is troublesome for the reader and often results in the reader ignoring the diagrams and tables. Consequently, the best place to put an illustration is close to the point in the text where the ideas embodied in the illustration are being discussed. If the illustration is mentioned several times in the text, it should be located near the first point of reference. Never insert an illustration without referring to it in the text.

If the illustration is smaller than a full page, it can be placed in the page of text itself. Microsoft Word and other word-processing programs have the capability to paste illustrations prepared in a graphics software package into your final text document. The general convention is to place the illustration just after the paragraph in which it is first mentioned. It is not appropriate to place an illustration in the middle of a paragraph. Be certain that the word-processing program lays out the pages without large blank spaces at the top or bottom of any page. If this occurs, you may need to move the illustration either forward or backward in the text. Remember that the goal is to place the illustration so the reader may see it conveniently while reading about it.

If an illustration requires a full page, then it should be placed directly after the page on which it is first mentioned. The page with the illustration should be paginated in the regular fashion; i.e., if the illustration is mentioned on page 17 of the text, it should be page 18, not 17A or, even worse, unnumbered. Illustrations larger than the size of one page can be made up as fold-outs. Because they are often cumbersome, these should be put in an appendix of the report and their location noted in the table of contents.

In summary, the point in placing illustrations is to make it as easy as possible for the reader to refer to them.

APPENDIX H: GUIDELINES FOR ORAL PRESENTATIONS

Speaking to audiences composed of listeners with varying degrees of competence and knowledge is not unusual for the professional engineer—nor is having time limits. These factors pose problems in adaptation that the speaker must consider when planning an oral presentations. The following list should prove helpful for presentation preparation:

•**Practice the presentation** so that it fits the allotted time and proceeds smoothly from one part to the next. Practice should include the use of audio/visuals designed for the report. Some students record their presentations on audio or video tape recorders, so they can review and improve their performance before they speak in class. Use of equipment for such practice can be arranged with the Science, Technology, and Society instructor.

•**If you use a Power Point presentation, include a slide at the beginning that shows the title of the presentation, your name, and if you chose, your advisor's names.** Otherwise, make that information available on the chalk board, or on the over head projector.

•**Do not read the presentation from a manuscript**. Note cards are permitted but should be used only for occasional reference, not as a substitute for a manuscript to be read.

•**Speak slowly and distinctly and maintain eye contact with individual members of the audience**. When pointing to a visual aid, do not "talk into" it.

•**Relate the approach to the topic to the interests of the class**. The introduction to the oral presentation should answer the question, "why should the audience be interested?"

•**Explain terms likely to be unknown to the audience**. If unsure, explain a term rather than risk puzzling the audience about it. Avoid long recitals of mathematical computations; they tend to bore and confuse audiences. Use handouts for these. (See section on handouts in Appendix I.)

•**If you use prepared audio/visual aids,** keep them simple, clear, and loud enough to hear or large enough to be seen easily from any part of the audience. (See Appendix I for guidance on using visual aids.)

•**Organize the presentation into clearly identifiable parts**, so that it has a clearly demarcated opening, development, and closing. A simple outline will help the speaker and the audience to follow from one major topic to the next. Transitions from one part of the presentation to the next should be clear and explicit (e.g., "*After I completed the mathematical analysis, I began work on the prototype.*")

•**Try to maintain a relaxed, friendly, and confident attitude**. Communicate your genuine enthusiasm for the topic. Do not apologize for your abilities as a speaker, or for lack of preparation. It is better not to call attention to such things.

•**Keep gestures and other body movements simple and natural.** Guard against distracting movements such as jiggling change in the pocket or pacing up and down the room. On the other hand, do not stand stiffly.

•**Have a conclusion to the presentation**. Do not say "*That's it*," or "*That's about all I have to say*." Rather, give a brief summary and state as succinctly as possible the major conclusion to the research. For example: *In conclusion, this project has presented a method for reconstructing coronal head scans from horizontally-oriented X-rays. It has established the feasibility of using computer-assisted tomography for a limited application in medical practice. Refinements in the procedure could possibly result in more finely resolved images and thus more widespread application.*

•**Have a brief, prepared recap to say after the last question from the audience has been answered.** This way, the final impression is one you can influence, rather than leaving the audience with what ever impression was left by the last question.

Oral Report Evaluation Forms (see example in Appendix J) are used by the STS advisor to evaluate the presentations given in STS 401/402. In some classes, students will be asked to complete forms for use in peer evaluations. Review this sheet as you prepare and practice each oral presentation.

APPENDIX I: VISUAL AIDS

Engineers and applied scientists use a variety of modern audio/visual aids during oral presentations. The chalkboard is still used at times, but has been supplemented, and largely replaced by other media that add clarity, impact, and professional polish.

Using “the real thing" is best when a device or process is easy to carry to an audience, If size or some other factor precludes actual demonstration or, if the real thing is not an effective visual aid, other media may help. One may wish to use a videotape or movie, for example; sometimes the combination of recorded sound and visual images is the best way to illustrate or explain pertinent information. With the growing popularity of computer technology and multi-media, a variety of computer generated simulations, graphics, and fonts may be used to convey key points to an audience. Other aids that may be used successfully include overhead transparencies, 35 mm slides, and printed handouts.

It is important to remember that audio/visual aids should be used only when they will contribute to effective presentation of the material. Use of aids that are merely clever and not pertinent to audience understanding can harm rather than help an oral presentation. (In fact, for this reason, some STS faculty members strongly discourage the use of Power Point in oral presentations of the proposal and thesis.)

Experienced speakers use media aids unobtrusively and naturally as a part of their presentations. They have their materials lined up, ready for use, and bring them into play smoothly and efficiently. Practice with the aids helps build competence in using them.

Types of Aids and Their Use

The following are descriptions of audio/visual aids and pointers for their use. The list at the end of this section indicates what equipment is available through the Department of Science, Technology, and Society and what must be supplied by students.

Computers and Multimedia Aids

The computer has the power to elucidate the most complicated concepts and can be a perfect platform to convey information to an audience.

Computer presentation software can be used to produce computer generated slide shows, animated graphics, and multimedia presentations. Many students use computers to simulate “real life” in a microcomputer environment. Furthermore, the portability of computers has also contributed to their burgeoning use as a presentation tool.

There are several reasons why computers should be considered as a tool for presenters. First, computers can save time and money because most students have access to computer labs and software packages. Where an old-fashioned slide show would require transferring information to film, developing film into slides, loading the slides into a projector, and running the projector, the materials and turn-a-round time required for

computer slide show presentations are limited to learning and operating software, inputting information or data, and running the program.

Another key advantage to using a computer in a presentation is its flexibility. Major or minor changes can be made to the visual aids with little effort. Students can change data or concepts moments before, or even during, their demonstrations. This flexibility allows for evaluation and revision that can improve the effectiveness of a presentation. Also, most computerized presentation programs have the ability to produce hard copies, slides, and transparencies.

Displaying computer information so that an audience can view it is getting easier, and the quality of the image is getting better. Laptop computers can be connected to LCD display panels and projected onto projection screens large enough for an audience to see. In the last several years, video and computer projectors have become increasingly affordable and more common as a method of projecting computer images.

These advantages have led to Microsoft PowerPoint and similar software packages becoming the *de facto* standard method for most engineering presentations. However, care should be used with these presentation tools. Use of poorly designed document templates, over-simplification of talking points, and limited or distractingly used graphics can lead to overconfidence by the presenter and failure to achieve the objective of informing the audience about the material.

Overhead Projectors and Transparencies

The overhead projector was specifically developed for visual presentation purposes. With the advent of laser printing technology and computerized copy facilities that can produce sharp, bold color transparencies, and a large installed base of comparatively inexpensive projection equipment, it remains commonly used.

An overhead projector passes light through transparent 8 1/2" x 11" acetate sheets on which an image has been drawn or photocopied and projects the image onto a screen. The projector runs relatively quietly and can be used with room lights on.

Because it uses projected light, the overhead projector commands audience attention. Another asset is that the acetate sheet lies on a flat surface accessible to the speaker and can be drawn on or pointed to. Thus, lines and arrows can be added for effect during the presentation.

Colored marking pens can be used on the transparency, and pieces of colored acetate sheets can distinguish sub-assemblies and steps in processes.

It is possible to use the overhead transparency in a revelation manner. Only part of the sheet is shown, the rest being covered by a piece of cardboard or other opaque material. The speaker moves the cardboard to "reveal" his or her next point or show the next part of an assembly.

Size of lettering and diagrams on overhead transparencies is important. Lettering should be about 3/8" high wherever possible. Some experimentation with diagrams may be needed to determine how easily diagrams can be seen when projected.

Tips and Hints on Utilizing and Preparing Transparencies

* Use bold and simple text, charts, diagrams, and graphics. Very fine print and detail do not reproduce well.

* Position information horizontally on transparencies because doing so covers the projected viewing area best.

* Each overhead transparency should convey a single concept; avoid clutter.

* Use the fewest words possible. Use key words to convey ideas.

* To maintain eye contact with the audience, avoid reading from your transparencies.

* Legibility Test- One quick way to check legibility is to lay the transparency on the floor over a white piece of paper. If you can read it from a standing position, your audience should be able to read it when you project it. To be absolutely sure, try it out on the projector in the room where you will make your presentation.

Video

Video is especially useful to show a device or process in action when it isn't possible to demonstrate the real thing. With current computers and LCD projectors, video display is usually as easy as any other computer-mediated presentation element.

Like any visual materials, video should be reviewed carefully before use, whether as DVD, VHS tape, or computer file. The speaker should pay particular attention to the length of the shots, or sequences on the tape, which should be no longer than necessary to make the point. It is possible to edit a video, to cut out unwanted sections, or to re-order sequences of shots. This may be done by use of multiple recorders, but is more frequently done by video capture computer hardware and editing software. The Digital Media Lab in the Clemons Library's Robertson Media Center have equipment for digital editing of sound, video, and images, and staff to assist students with related projects. Additionally, the STS department has some digital video cameras available for student and faculty use.

Note: Video used to convey a concept or demonstrate "the real thing" in a presentation can be very beneficial to the audience; however, video should not be used to fill time or to compensate for information

Printed Handouts

Sometimes it is desirable to give an audience a printed hand-out to follow during the presentation or for reference afterwards. PowerPoint and other presentation packages can be used to easily create handouts of slides, possibly including additional material not shown in the main presentation. This may be particularly useful for when a speaker wants to make information available that he or she will not have time to cover or that might bore or puzzle parts of the audience. Long mathematical computations are sometimes handled this way: rather than presenting them in the talk, the speaker will offer a handout for anyone who wants to see them.

Equipment and Materials for Preparation of Aids

The student must provide:

Flip-chart paper. Available at bookstores and art supply stores.

Audio and videotapes. Medium to high quality audio and video are highly recommended. Please see STS department Media Specialist for more information.

Available on loan basis from the Department of Science, Technology, and Society for oral presentations are:

- Laptop computers and LCD display devices. (Special conditions apply.)
- Video cameras.
- VCRs and monitors.
- Video projectors
- Overhead projectors
- Portable screens
- Flip chart easels
- 35 mm slide projectors and carousals
- 16 mm film projectors.

APPENDIX J: ORAL REPORT EVALUATION FORMS

Oral Presentation Evaluation Form (sample 1)

Department of Science, Technology, and Society

School of Engineering & Applied Science
University of Virginia

Name _____

Date _____

OPENING: (Goal: gain immediate attention and respect; announce the subject, scope, and relevance to the audience.)

DEVELOPMENT: (Goal: make the material intelligible to the specific audience; provide adequate expansion, key definitions, appropriate examples, smooth transitions, and clear emphasis.)

CONCLUSION: (Goal: simple summary of main points; recommendations for action; graceful termination of speech and/or forthright consideration of audience questions.)

DELIVERY: (Goal: confident, articulate, well paced, committed to communicating the message.)

VOICE:

GESTURES/BODY CONTROL:

EYE CONTACT:

VISUAL AIDS: (Goal: help clarify and simplify the message.)

OTHER:

Grade _____

STS 401—402 Oral Presentation Evaluation Form (Sample 2)

Grading Rubric:

A range—Outstanding, enlivened presentation which captures and holds the audience's interest throughout; exceptionally well organized, providing a clear, memorable message with an appropriate level of detail; relatively easy to understand and to follow.

B range—Good/Very good presentation which conveys just the right amount of information in an understandable and interesting way; engaging the audience and explaining key concepts clearly.

C range—Acceptable presentation which offers a coherent explanation of the thesis project, but with a weak connection to the audience; moderately well organized.

D range—Presentation which is difficult to follow, fails to establish a good rapport with audience, and over which the audience struggled to maintain interest.
.
F range—Presentation which exhibits little effort on the part of the speaker, either in audience adaptation, or in the content itself.

Name_____

Start Time _____ End Time _____

Evaluation

I. Presentation Introduction:

____Attention getting device used successfully
____Topic stated clearly
____Central Idea/Enumerated Preview Provided
____ Audience rapport well established

II. Body:

____Organizational Pattern is logical and effective
____Main Points Clear and Distinct
____Appropriate Number of Main Points
____Transitions smooth
____Variety of types of Supporting Materials used
(examples, testimony, statistics, comparisons, etc.)
____Citations or acknowledgements given where needed
____Available means of communication used
____Appropriate and effective audio/visual aid support

III. Conclusion:

____Signaled Conclusion
____Reinforced/Summarized Central Idea
____Concluding Device

IV. Style:

____Appropriate use of Language
____Accurate use of Language
____Clear use of Language
____Vivid use of Language

Delivery:

____Eye Contact
____Rate
____Gestures
____Movement
____Facial Expression
____Vocal Variety
____Posture

General:

____Topic appropriately adapted in detail, length, breadth
____Finished within time limit
____Adapted to Audience throughout Presentation

What strengths did the speaker demonstrate?_____

_____

_____

What are some areas for improvement?_____

_____

_____

Presentation Grade: _____