

1.018/7.30J Fall 2009 Ecology I

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**Keep it as simple as
possible, yet no simpler.**

Albert Einstein

The fundamental purpose of scientific discourse is not the mere presentation of information and thought but rather its *actual communication*. It does not matter how pleased an author might be to have converted all the right data into sentences and paragraphs; it matters only whether a large majority of the reading audience accurately perceives what the author had in mind.

--George Gopen and Judith Swan
The Science of Scientific Writing

How well you communicate affects your career



Survey (Richard M. Davis)
Successful engineers spent 25% of work week writing



Survey (Wisconsin)
Professional engineers found writing their most useful subject in college

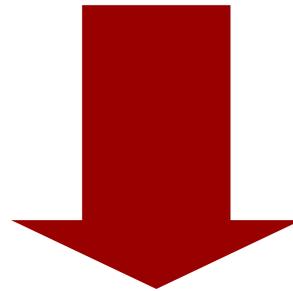


Survey (Virginia Tech)
Recruiters claim that engineers need more work on their writing

Scientists and engineers are called upon to communicate in many different situations

**Reports
Articles
Proposals
Web Pages**

**Conferences
Lectures
Meetings
Posters**



**specific
technical
audiences**

**general
technical
audiences**

**non-technical
audiences**

In scientific writing, formats vary considerably to serve different situations

**Formal
Reports**

**Journal
Articles**

**Presentation
Slides**

The majority of your work is communicated in a variety of documents

What is a document?

Like most engineering projects, a document is an artifact that is designed and produced

- It is created
 - For specific purposes
 - For specific audiences
 - For specific uses
- It is modular

The structure of a document is reflected in the headings, subheadings, and paragraphs

**Today's talk will overview the term project,
consider structure, overview the Project
Description**

The Term Paper consists of a series of **five assignments, which will be completed in stages**

- 1) Topic Submission..... Due Lecture #3**
- 2) Project Description..... Due Lecture #7**
- 3) Introduction..... Due Lecture #11**
- 4) Experimental Design/Proposal....Due Lecture #15**
- 5) Complete Final Paper..... Due Lecture #22**

*** Oral Presentation: (15% of term project grade)**

The final proposal includes all revised sections, and Conclusion & Recommendations

5) Complete Final Paper: This is the final product, your complete Term Paper. It should include the six sections detailed below.

Title Page: Your Final Paper should have a cover page with your name, date, and the title of your paper. The title should be descriptive of both the geoengineering topic you've worked on and the experiment you've proposed to test its unintended consequences.

Executive Summary: Your Final Paper should start with a 250-500 word summary of the entire paper. You should use this as an opportunity to explain why the experiment you've proposed is important. Justify it by summarizing the problem, geoengineering idea, and potential problems with this idea. You should also describe what you expect to find with your experiment.

Introduction: Your Final Paper should include a **revised** version of the Introduction that you submitted earlier in the course. Be sure to pay close attention to the editorial comments of your graders and to transitions between your sections!

Experimental Design Proposal: Your Final Paper should include a **revised** version of the Experimental Design that you submitted earlier in the course. Be sure to pay close attention to the editorial comments of your graders and to transitions between your sections!

Conclusions and Recommendations: Your Final Paper should conclude with a 500-1000 word section that highlights the predicted results of your experiment and what these results might mean for your opinion regarding implementation of this and of other geoengineering strategies. This is a chance for you to put your experiment in the context of dealing with global problems as a whole. You should write your own recommendations based on your research.

Bibliography: You should have at least 15 peer-reviewed references written in APA format (see CI instructors for formatting details).

Your complete Final Term Paper should be around **2750-4500 words** (double-spaced, 11 pt Arial font, 1" margins), excluding front matter, references, figures and tables. It must be accompanied by at least fifteen peer-reviewed references. It is due on **December 1, 2009**, and it is worth **40%** of your Term Paper grade.

Your Introduction should consist of three parts, which:

- 1**
 - Discusses the issues and attributes of the problem addressed by the topic you've selected.
 - Identify the problem's implications ecologically and socially, etc.
 - Provides a foundation for your reader to understand the problem through a discussion of the literature.
- 2**
 - Reviews the origins and history of the concept of geoenineering, and summarize a broad suite of proposed schemes
 - Demonstrates themes, problems, negative side effects or other ideas common to these various strategies.
- 3**
 - Provides an in-depth analysis of the particular geoenineering topic that you've selected.
 - Discusses how it is supposed to work, providing technical details and diagrams if appropriate.
 - Cites relevant literature to provide the necessary details.
 - Describe the "intended consequences" of your geoenineering topic, i.e. what is it supposed to do and why?

Your Experimental Design should consist of three parts, which

- 1
 - Reviews the potential unintended consequences of implementation of the geoengineering idea.
 - Explains what might go wrong, how it might negatively impact the Earth System, etc.
 - Provides a literature review of the relevant material.
- 2
 - Proposes a hypothesis regarding the testing of these unintended consequences. Your hypothesis should reflect your prediction of what your experiment will determine.
- 3
 - Proposes the actual experimental design that you've developed to test the hypothesis you've put forward regarding the unintended consequences of your geoengineering topic.
 - Includes technical details, diagrams, and experimental details (replicates, controls, etc.)
 - This is the experiment you are proposing and whose funding will have to argue for in your presentation. Your design must be scientifically reasonable and this will require literature reviews.

Your Conclusions and Recommendations should:

- 1 • Highlight the predicted results of your experiment and what these results might mean for your opinion regarding implementation of this and of other geoengineering strategies.**
- 2 • Put your experiment in the context of dealing with the global problems as a whole.**
- 3 • Include recommendations based on your research.**

Structure: Use Section Hierarchies to Clarify Structure, Use headings for major topics

Executive Summary

Introduction

- Problem/Background
- Geoengineering overview
- Description of specific scheme

Experimental Design

- Potential unintended consequences
- Hypothesis
- Description of Experiment

Conclusion/Recommendations

- Expected results
- Conclusion
- Recommendations

Outline/Structure for Experimental Design Section, example:

Experimental Testing of GM Trees

Section Heading

Proposed testing mechanisms for intended and unintended consequences of implementation

Introductory text

The usefulness of using GM trees as a Geoengineering solution remains uncertain. Both intended and unintended consequences of the project require further research and testing. We propose the following experimentations to verify efficacy, and to test potential hazards. All experiments are modeled after similarly formatted tests that have been either executed or proposed.

Proposed Hypotheses for Unintended Consequence Testing

Large Scale Setup

Efficacy Testing- GM trees and Carbon Sequestration

Testing Risk of Gene Flow-

Testing Effects of Mixed Forests- Changes in Resources and Biodiversity

*Subheads/
Subsections*

The organization of a document is reflected in the headings, subheadings, and paragraphs, example:

Genetically Modified Trees

Section Heading

A Geoengineering Scheme to Reverse Anthropogenic Environmental Changes

Geoengineering is an intended large-scale modification of the Earth's systems to reverse human induced damage. Often focused on carbon emissions, geoengineering can also attempt to reverse sweeping human actions including deforestation, and pollution. The use of genetically modified trees (GM trees) for reforestation, addresses the repercussions of all of these actions. Benefits of GM trees include improved carbon sequestration, alternative energy, and bioremediation. Companies such as *Arborgen* have begun to genetically modify trees for such purposes. There still, however, remains multiple side effects including mutations, undesired changes in the biogeochemical cycles, and biodiversity limitation. These unintended consequences have potential to out way the proposed benefits.

Mutations

Subheads

Changes in the biogeochemical cycles

Biodiversity limitation

Writing your Project Description, a sample

Name: Hermione Granger

1.018j/7.03, Fall 2009

Term Project Assignment #2, Project Description

Comment [H1]: Include your name and relevant assignment information. Remember that this is a formal document.

Overview of Project Proposal for Testing the Unintended Consequences of an Iron Fertilization Geoengineering Scheme

Comment [H2]: Include a brief working title that contains enough information to orient the reader to the content of your proposal description.

Summary Statement and Statement of Research:

Iron Fertilization of the oceans has been proposed as a geonoengineering scheme for reducing the increasing levels of CO₂ in the atmosphere in order to reverse global climate change. As this geoengineering scheme has potentially dangerous unintended consequences, I am proposing to develop a model for determining the unintended consequences of an iron fertilization scheme.

Comment [H3]: Consider beginning with a brief summary statement (about three sentences). This statement might be an updated version of your topic proposal.

I have completed the majority of research on the background of the problem and on the iron fertilization scheme that I will be testing, but I am still researching the science behind my methods for collecting the data that will be used for the model.

Comment [H4]: You can also add a brief explanation of your current state of research. Alternatively, you can also add statements relating to your research within the appropriate subsections. Your evaluators will find this information useful in providing you with appropriate feedback (and possibly for pointing you toward relevant sources).

I. Introduction

- a. The “problem”: This section will describe the ecological and social issues involved in increased CO₂ concentration. Raynaud *et al.* (1993) and Vitousek (1994) provide examples of the changes in CO₂ concentration over the past 150 years. Pidwirny (2006) describes the resulting global warming; Vitousek (1994) describes effects in both terrestrial and marine ecosystems.
- b. Geoengineering, history and literature review: This section will first describe the history of geoengineering (mainly derived from Keith, 2000), then survey other proposed schemes such as those to enhance the Earth’s albedo (Rasch *et al.*, 2008; Latham *et al.*, 2008). In particular, themes and problems with these schemes will be highlighted.
- c. Geoengineering scheme to be tested, Iron Fertilization: This section will provide and in depth explanation of the scheme to employ Iron fertilization to sequester carbon by increasing the growth of phytoplankton; Denman (2008) gives a more complete description, and has a useful figure. The basic model and the intended consequences will be explored and analyzed. Currently, I am still reviewing source material on specific proposals.

Comment [H5]: Use the same structure for the overview of your sections in the Project Description as you will in the final Proposal (see Term Project handout for details of section requirements). For example, the Introduction should be structured as follows: a. problem description, b. geoengineering overview, c. description of the geoengineering scheme that you will be testing.

Comment [H6]: Beginning each subsection with a clear statement of purpose will help frame the coming information for the reader and will help you to focus your explanation.

Comment [H7]: The brief headings help to orient the reader to the coming information, provide structure, and help you to focus on the topic that you will be describing.

Comment [H8]: Note how the

source material on specific proposals.

II. Experimental Design Proposal

- a. Potential unintended consequences: This section will describe the potential unintended consequences of implementing an iron fertilization geoengineering scheme. Current literature will be reviewed. For example, Assmy et al. (2007) demonstrated that iron fertilization favors the rapid growth of certain species of phytoplankton over others, which may affect the marine food web. A computer model by Sarmiento and Orr (1991) suggests that iron fertilization can decrease oxygen concentration in the ocean by up to 50%. Iron fertilization may also affect the atmosphere by increasing the amount of such harmful gases as nitrous oxide

and methane (Fuhrman & Capone, 1991). Focus will be placed on the unintended consequences that will be relevant to my proposed experiment.

Comment [H8]: Note how the descriptive overview of this section follows the requirements set forth in the Term Project handout.

Comment [H9]: Writing. Note that much of the writing is in the passive voice ("This section will describe" vs "I will describe..." - active voice). While the active voice is preferred for the majority of your proposal, the passive voice can help to highlight the process itself (which is why it is often preferred when describing methodology). Try to be aware of when you are using active voice and when you are using passive voice.

Comment [H10]: Note the use of sources for support. In-text citations are in APA format.

II. **Experimental Design Proposal**

- b. Hypothesis: I hypothesize that my tests will show that the potential unintended consequences are of minimal magnitude or are dire. Note: sample term paper lacked an explicit hypothesis, but did state goals of experiment: (1) to determine the true efficacy and carbon sink capability of the HNLC regions of Earth in response to *prolonged* iron fertilization; and (2) to measure, model, and quantify the potential adverse ecological and biogeochemical effects.
- c. Proposed experiment: This section proposes an experiment that will collect data that will be used to create models for predicting the unintended consequences of an iron fertilization scheme. My experiment will take place in the equatorial region to reduce a number of variables. Measurements will be taken over 18 months – much longer than the duration of previous experiments (generally over a month, according to Denman, 2008) – in order to assess the effect of the various cyclical processes of the Earth's oceans. The experiment will measure carbon, nutrient flux, and harmful gases.

III **Conclusions and Recommendations**

- a. This section will begin with a conclusion that predicts the results of my experiment. Currently, I anticipate
- b. If the results are as described in "a," I anticipate that I will discuss the following....
- c. Building on what has been discussed in "a" and "b," and according to my research, I will make the following recommendations.....

Comment [H11]: This section will be difficult for you to flesh out at this point. Make reasonable conjectures, if possible, to start yourself thinking about what type of information will go in this section and how i

References

- Assmy, P., Henjes, J., Klaas, C., & Smetacek, V. (2007). Mechanisms determining species dominance in a phytoplankton bloom induced by the iron fertilization experiment EisenEx in the southern ocean. *Deep Sea Research Part I: Oceanographic Research Papers*, 54(3), 340-362.
- Denman, K. L. (2008). Climate change, ocean processes and ocean iron fertilization. *Marine Ecology Progress Series*, 364, 219-225. doi:10.3354/meps07542

Comment [H12]: The Reference list (bibliography) is in APA format. You should include all of the sources that you cited in the Project Description (this list is incomplete simply to save paper).

For References use APA Format – Best, try Reworks, examples:

Journal article:

Fine, M. A., & Kurdek, L. A. (1993). Reflections on determining authorship credit and authorship order on faculty-student collaborations. *American Psychologist*, **48**, 1141-1147.

Book:

Nicol, A. A. M., & Pexman, P. M. (1999). *Presenting your findings: A practical guide for creating tables*. Washington, DC: American Psychological Association.

Book chapter:

O'Neil, J. M., & Egan, J. (1992). Men's and women's gender role journeys: Metaphor for healing, transition, and transformation. In B. R. Wainrib (Ed.), *Gender issues across the life cycle* (pp. 107-123). New York: Springer.

Online document:

Author, A. A. (2000). Title of work. Retrieved month day, year, from source (give URL)

Use diagrams for explaining your experimental design

Don't forget that Writing Is a Process

Good writing doesn't happen overnight; *it requires planning, drafting, rereading, revising, and editing.*

Learning and improvement requires *self-review, peer-review, subject-matter expert feedback, and practice.*

There are *no shortcuts*; practice makes perfect!

You choose the information, how it is presented, and how it is analyzed.

“Objectivity is the basis of research, but effective communication of science requires some subjectivity on the part of the writer”

- Amin Bredan & Frans van Roy

Reread, revise your writing for clarity

Attention to the clarity of subjects and to logical connections helps the reader follow complex discussions

Global warming poses many potential risks to the Earth's ecosystem and human existence. Not only are the natural cycles, including the water and carbon cycle, thrown off balance, but **effects** such as the melting of polar icecaps may wipe out entire species. **Other negative effects** include changes in the geographical distribution of vegetation, and increased sea levels. **Effects of global warming on the human population** include difficulties sourcing energy, transportation, food, and water. **Because of these effects**, there will be a change in health and infrastructure causing potential famine, and disease in **many parts of the world** (Wuebbles, 2001). **The poorest parts of the world** are at most risk of these effects both because of their financial disadvantage and their rapid population increase. Thus, as the chemical imbalance of the atmosphere continues to cause global environmental changes, mankind may have to **engineer radical methods** to undo these anthropogenic effects. **Geoengineering** holds the possibility for such solutions, and for this reason has gained much public attention.

Knowing your Audience(s) for your Proposal is Crucial

NSF Seven Deadly Sins of Proposal Writing

1. Failure to focus on the problems/payoffs
2. No persuasive structure: *poorly organized*
3. No clear differentiation: *competitive analysis*
4. Failure to offer a compelling value proposition: *potential impact*
5. Key points buried: *no highlights*
6. Difficult to read: *full of jargon, too long, too technical*
7. Credibility killers: *misspellings, grammar inconsistent format, etc.*

Use your Communications and Writing Resources

CI/WAC Lecturers

Harlan Breindel

Leslie Roldan

Mary Zoll

The Mayfield Handbook of Scientific and Technical Writing

Academic Integrity at the Massachusetts Institute of Technology: A Handbook for Students

The Science of Scientific Writing by Gopen & Swan

The Writing Center

MIT OpenCourseWare
<http://ocw.mit.edu>

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