Engineering and Scientific Projects

Two kinds of projects

– Make something.
  Results
  1. The “thing” (Prototype, or the thing itself)
  2. Documentation (sometimes)
– Investigate something.
  Results: Documentation

Both types of projects are normal activities in engineering and science.

Some projects are infeasible.

Reasons why a proposed project can be infeasible.

- Violates physical law.
- Too advanced for state-of-the-art.
- Cannot be done in available time.
- Cannot be done with available funds.

TECHNICAL PROPOSALS: Content and Format

Every engineering project begins with a technical proposal

- Some proposals are short and informal (maybe even oral)
- Some proposals are very long and formal.
- Most proposals are moderate in length and content.

The goal of a technical proposal is to SELL something!

What are you selling?
- New idea
- Technical capability to perform a given task.
- Both of above

To whom are you selling?
- Employer
- Customer

Proposals can be either *solicited* or *unsolicited*

- Solicited proposals try to sell your capability to perform a project that the "customer" requests.
- Unsolicited proposals try to sell your idea, plus your capability to carry out the necessary work.

Technical proposal should convince reader to support your project.

What is needed to convince reader?

Project is worth doing.

- Idea has technical merit.
- It has not been done before.
- Payoff, if successful, is significant.

You have the knowledge and skills necessary to do it.

It can be done in the available time.

Budget is reasonable.

Written technical proposal should contain information necessary to convince the reader.

TYPICAL FORMAT OF A TECHNICAL PROPOSAL

Recommended for Senior Project Proposals

- Cover Page (title, name, purpose, date)
- Table of Contents
- Abstract (or Executive Summary)

NUMBERED SECTIONS:

1. Introduction
2. Technical Discussion
3. Outcomes
4. Statement of Work (including schedule chart).
5. Qualifications
6. Budget
7. References

Appendices

To be included in the above sections:

Abstract or "Executive Summary" is a very brief description (no more than one page) of the purpose and outcomes of the project. Should "sell" the project to reader who reads nothing else.

Introduction gives an overview of the project and gives a perspective of its place and role in a given field.

Technical Discussion. Should convince reader that you understand the technical issues and know what to do about them.

Outcomes. Emphasizes the result of the project (new or improved device, data, valuable educational experience, etc.).

Work Plan ("Statement of Work")
A task-by-task description of all the things that need to be done in order to complete the project. Should convince the reader that you have given consideration to all the details.
Includes Schedule ("Milestone Chart", PERT Chart), showing when each task will be started and completed.

Qualifications. Background of organization and (key) individuals who will participate in the project that they have the necessary qualifications.

Budget. Prices of key parts and components, labor and services. (In students' project proposal do not include labor)

References. Listing of books, articles, software, websites, etc., which provided information used in the document.

Appendix. Can be more than one. Contains supplementary information not included in the main text. For example, manufacturer data sheets on key components like sensors, actuators or special chips to be used in the project.

How to prepare technical discussion

Read up on subject (begin bibliography)
- Popular magazines (e.g. Scientific American, Electronic Music)
- Trade journals (to find out state-of-the-art in hardware.)
- Technical journals (for new theory)

Confer with “customer” and other knowledgeable individuals.

In Technical Discussion section

Describe project in detail (peer-to-peer)

Identify technical “risks” — critical problems.
- Untested theory
- Availability of hardware, software
- Time, cost.

Discuss what you will do to make the project succeed, despite the risks.

Discuss any special knowledge or experience you have which may contribute to solving the critical problems.

<u>Statement of Work</u> (or Program Plan)
is a Task-by-Task description of all the things you need to do in order to complete the project.

- Organizes your thinking about the project
- Shows the customer that you understand scope of the project.
- Used during project to check and report your progress.
- Is coordinated with project schedule.

Possible Statement-of-Work for an electronics project

Tasks

1. Literature review
2. Design circuits
3. Simulation
   - Individual circuits
   - Overall system
4. Construct and test breadboard
   - Order necessary components
   - Wire breadboard
   - Test breadboard
5. Design and test printed-circuit board (PCB)
   - Acquire software
   - Create artwork
   - Create mask
   - Order prototype
   - Assemble
   - Test
6. Packaging of product
7. Documentation
   - Demonstration of the circuit
   - Progress reports
   - Final report

Milestone chart (or PERT chart) is a graphical presentation of events and activities of the project and the times at which they begin and end.

Milestone chart has several purposes:

- Focuses attention of planner on important events, especially when
- several activities are conducted concurrently.
- Demonstrates to customer understanding of critical issues.
- Used during course of project to track project.

Chart may show individual events or continuing activities.

Individual events

- Periodic report
- Oral report
- Design review
- Place order
- Receive order

Continuing activities

- Literature survey
- Construction
- Testing
- Writing computer code

Example of Milestone Chart for Investigation

1. *Literature review*	Time
2. *Design test apparatus*	-“-
3. *Construct test apparatus*	-“-
4. *Conduct tests*	-“-
5. *Evaluate results*	-“-
6. *Documentation*	-“-
Progress reports	-“-
Final report	-“-
Oral presentation	-“-

Example of Milestone Chart for Electronics Project

1. *Design*
   - Circuit 1, Circuit 2
2. *Simulation*
   - Circuit 1, Circuit 2, Overall
3. *Breadboard*
   - Circuit 1, Circuit 2, Overall
4. *Printed-circuit board*
   - Acquire software, Create artwork, Create mask, Assemble, Test
5. *Packaging*
6. *Documentation*
   - Demonstration of the circuit
   - Progress reports
   - Final report
   - Oral presentation

Remarks about milestone charts

- Software for creation of charts is available
- Symbols are not standard

Make-or-buy decision

In designing something, you often must decide whether to make or to buy something.

Reasons to “make”

– Not available in market.
– Cost
– Delivery time
– Develop skill
– Management direction

Reasons to “buy”

– Cost
– Availability
– Reliability
– Management direction
– Customer direction