

Technical Report Writing Skills and Techniques

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1 Introduction

As an engineer, you will be required to document the work you perform. When preparing research, designing products or examining alternative approaches to solve a certain problem, you will need to write proposals for the work about to be performed. After the project has been completed, it is then necessary to formally document your results either for company reports or for publication.

As a student, you are given projects to perform. As you move from second year to third year and finally to fourth year, you will need to cope with increasing complexity and more demanding projects. Eventually, the experience you have obtained in carrying out projects and documenting your ideas will be required for your undergraduate final year thesis: a 10,000 word document! Hence, the purpose of these projects is three-fold:

1. they give you a practical understanding of working in teams,
2. they develop your practical skills, and
3. they give you the opportunity to develop your skills in technical writing as you document the project at its various stages of development.

Each report should be written in such a way that it demonstrates your knowledge and your thinking skills. The aim of these guidelines is to help you understand how the information obtained and generated through the course of the project is best organised and presented on paper.

This document provides an overview of how to write better technical documents. The document describes how to write effective reports covering the following areas:

- Steps commonly used for writing effective documents.
- Steps for improving your writing.
- Incorporating tables and figures into documents.

The majority of this section was summarised from Markel [1]. Other books on technical writing of interest are [2,3,5]. Students whose first language is not English may find useful suggestions in [4].

2 Characteristics of Effective Documents

There are a number of characteristics of an effective document. These characteristics can be summarised as follows:

- The document should include all the information the readers need. This means including important information relevant to the document as an appendix and cross reference or cite documents that contain less important information. An effective document should also provide a background section if the audience includes readers unfamiliar with the topic. The document should include a clear description of the writer's methods, as well as a complete statement of the principle findings. These findings include the results, observations (discussion), and any conclusions.

- Design documents should include information about *why* design decisions have been and carefully justify those choices. Explanation is the principle purpose of the document. Careful explanation of reasoning for design choices allows the reader to evaluate your design against their own ideas.
- The document should be structured so that readers can easily locate the information they seek. Some readers are interested in only one or several sections of a document. Other readers might read most of them. But relatively few people will read the whole document from start to finish, like a novel. To achieve this, discussions should be self-contained, and headings and lists easy to identify. Also for reports, a detailed table of contents should be given.
- Your writing should be as concise as you can make it without sacrificing content. One way to shorten a document is to replace long words and phrases with short ones. Short documents are better than long documents.
- Workplace writing is meant to get a job done, not to show off your personal style. The reader should be thinking about the subject you are writing about and not about you.
- Always acknowledge your use of other people's ideas or words by citing them. This involves referring to information that you may have read by citing the document from which it came (and possibly the section in the document if it is a book).

3 Steps for Writing

This section discusses the steps commonly used to write effective documents. This involves gathering your ideas, organising them, drafting the document, and finally revising the document.

Generate ideas to include in the document. Before you start writing, you must decide what information the document will contain. One particular method for generating ideas is brainstorming. Brainstorming involves quickly listing all the ideas that might be appropriate for the document. Write ideas quickly without trying to organize them; this organization will be done next.

Organise your ideas using some kind of outline. This involves ordering your ideas into some structured pattern. Examples of patterns are:

1. Chronological: This pattern is useful if the reader needs to follow your discussion in order to perform a task.
2. Classification: This involves placing items into logical categories.
3. Partitioning: This involves breaking a single entity into its logical components.

Write the draft quickly. This involves quickly turning your outline into sentences and paragraphs. Don't worry about individual words and sentences; leave this until the revising stage.

Spend your time revising the draft. After writing the draft, leave the document for as long as possible. When revising the draft, the following areas should be looked at:

1. Comprehensiveness: Have you covered everything in your outline, and have you gone into sufficient detail to make the message clear?

2. Accuracy: Make sure all your data and statements are accurate.
3. Organization: Does the information follow a clear and logical order?
4. Emphasis: Provide the same level of information on each sub point? If a certain point needs more clarification than another, then structure the discussion accordingly.
5. Paragraphing: Does each paragraph have a clear topic sentence that summarises the information that follows? Is the paragraph logically organised and developed?
6. Style: Check for sentence variety (don't keep using the same phrase over and over), grammar and punctuation mistakes, and awkward sentence constructions.
7. Spelling and Grammar: Always check for spelling and grammar mistakes by using either a spell checker *and* having someone else read the document. Spelling and grammar errors are almost always visible when someone else reads the document.

4 Improving Your Writing

This section discusses ways to improve the coherence of your writing. This means that the document should follow from one idea to the next smoothly without having to re-read the sentence or paragraph to grasp its meaning. The reader should be able to read the document once without getting lost by what you are saying.

4.1 How to Provide Structure

Use informative titles and headings. Titles and headings should be sufficiently precise and easy to read and understand.

Use lists to communicate parallel information. Many sentences become quite long and complicated. Information that is parallel should be presented as a list, either vertically or horizontally. These lists can either be numbered or listed using bullets.

Use introductions to forecast discussions. Because you know the subject better than the reader, you must adequately explain what information you are going to present, how you're going to present it, and why you're presenting it that way. The questions you need to ask yourself are:

1. What is the subject?
2. What is the purpose of the discussion?
3. What is the background of the subject?
4. What is the scope of the discussion?
5. What is the organization of the discussion?
6. What are the key terms that will be used in that discussion?

Use conclusions to complete discussions. This is done by answering the following questions:

1. What are the main points established in the document?
2. What should be done next?

The second question would only need addressing if there is any future work involved.

4.2 How to Write Better Paragraphs

This subsection discusses the structure of effective paragraphs. Effective paragraphs simply state the idea and then explain or defend it. Hence, paragraphs begin with a clear topic sentence, and then support this idea logically. The paragraph should contain certain words and phrases to help the reader make the transition from one sentence to the next.

There are four steps in writing an effective paragraph:

1. Begin with a clear topic sentence.
2. Support the topic sentence logically.
3. Emphasise the coherence of the paragraph.
4. Keep paragraphs to a manageable length.

4.3 How to Write Better Sentences

This subsection describes how to improve the style of your sentences. Style is how you sound when someone reads what you have written. You need to be straightforward, clear, concise, unpretentious, authoritative, and easy to understand. You do not want to be pompous, unclear, and verbose.

Use the active and passive voices appropriately. The active voice focuses on the performer of the action, whereas the passive voice focuses on the recipient of the action. The active voice is usually more precise and less wordy than the passive voice. In general, the active voice is preferable.

Use appropriate tense. Whenever you quote or discuss previously published work (possibly your own), you should use the present tense. Whenever you present your own work (i.e. the work you did in an experiment), you must use the past tense.

Choose appropriate sentence patterns.

There are four types of sentences:

1. Simple: The simple sentence has only one independent clause.
2. Compound: The compound sentence has two independent clauses, linked by a semicolon or by a comma and one of the seven coordinating conjunctions: and, or, for, nor, so, but, and yet.
3. Complex: The complex sentence has one independent clause and at least one dependent clause.
4. Compound-complex: The compound-complex sentence has at least two independent clauses and at least one dependent clause.

The most useful types of sentences for technical writing are the simple and complex. Further details of these sentence types can be found in Markel [1].

Use modifying elements effectively. There are two types of modifiers:

1. Restrictive Modifiers
2. Non-restrictive Modifiers

Restrictive modifiers restrict the meaning of the word (i.e. they make the word more specific). Non-restrictive modifiers simply provide extra information about the word.

Keep parallel items parallel. Do not turn parallel information into sentences. Either use a list, or number each item in the sentence.

4.4 How to Choose the Right Word

At the most fundamental level, good writing relies upon the selection of appropriate words and phrases. Word choice will also impact your writing style.

Choose simple, clear words and phrases. Picture yourself speaking on the phone to a good friend. If you would be embarrassed to have the person hear what you have written, change it.

Replace fancy words and phrases with plain words and phrases. Plain expression will convey your meaning more accurately to a wider audience.

Think about your audience. Consider who will be reading this document. Use words and phrases for your intended reader.

5 Creating and Integrating Graphics

A picture can replace a thousand words. Appropriate use of graphics can ease the burden of explanation. When you find yourself writing sentences such as “part A connects to part B through connector C”, you should probably be drawing a diagram instead. This section describes some guidelines for the use of graphics in a written document.

Make the graphic self-sufficient. Support the figure or table with text to allow the reader to examine the figure without having to read the supporting text to understand its significance. Always label axes on graphs (also giving units). Do not simply reproduce a CRO screen; graph the data you obtained from the CRO.

Determine whether you need graphics: Do not construct tables unless repetitive data must be presented. Do not simply present reams of data because you have them in your workbook; only present the important information. Do not use graphics to make a document “pretty”: use them to present information.

Determine what kind of graphic to use. If a graph presents that data better than a table (i.e. it shows the significance between certain values better), then use a graph.

Determine where to put the graphic. Place the graphic as close to the reference in the text as possible. Normally, it is placed on the same page or the page following.

Tie the graphic to the text. This involves introducing the graphic and explaining its significance, cross-referencing appropriately (eg. Figure 1: Title of figure) and referring to the label Figure 1, or Fig. 1, in the text. Tables and figures should use separate numbering sequences.

6 Improving Page Design

This section lists a number of areas for improving the clarity of the information contained on the page.

- Leave adequate margins.
- Use appropriate line spacing.

- Use appropriate justification.
- Use easy-to-read fonts.
- Use different members of a single type family.
- Use type sizes appropriately.
- Use uppercase and lowercase.
- Design titles and headings for emphasis and clarity.
- Design lists for clarity.
- Include page numbers on all pages.

7 References

[1] M. Markel, *Writing in the Technical Fields*, IEEE Press, 1994.

[2] R. A. Day, *How to Write and Publish a Scientific Paper*, Oryx Press, 1994.

[3] H. B. Michaelson, *How to Write and Publish Engineering Papers and Reports*, Oryx Press, 1990.

[4] T. N. Huckin & L. A. Olsen, *Technical Writing and Professional Communication for Non-native Speakers of English*, McGraw-Hill, 1991.

[5] A. M. Wilkinson, *The Scientist's Handbook for Writing Papers and Dissertations*, Prentice Hall, 1991.

Introduction

The RoboRoos system have camera that is connected to frame grabber in a PC that does vision processing to work out where the robots are so that the radio can tell the robots where they are and where the ball are and where the opposition is. This is how they play soccer. We re-did the vision stuff in 1999 and it works good. We worked hard on the navigation and its pretty good now. The navigation is one of the coolest things about our robots. There is also a potential field based multi agent planning system which has been focus of our concerted efforts to establish as a best practice operation. MAPS forms cooperative strategies by observing team agents at the current point in time and choosing appropriate actions to increase the likelihood of cooperation in the near future. Actions that come from MAPS are tranmitted to the robots we use the radio to transmit the actions. Like we said before, We use the radio to transmit the informations about what the vision saw. The radio have problems when there is the interference from the outside. We tried to fix this problem. The robots use the information from the communications link to set the current goal for navigation, and to build representations of obstacle maps for path planning.

I'll tell you about the goalie later. There is a table that shows how we done. We haven't done much to the electrical and mechanical stuff over the years we have done lots of work with the computer programming. We been doing robot soccer longer than most teams and we done all right but we haven't won the confrontation yet. If we get better then we will probably improve, otherwise we will be staying about the same. I think we should try to get better.

EXAMPLE OF POOR WRITING

Year	Round Robin Goal Difference	Final Result
1998	5-3	2nd
1999	56-1	Quarter final
2000	36-2	4th

Table of results

We have some other papers about our robot soccer team as well that are also interesting. This time we are writing about some new stuff that we have done. The new stuff affects several parts of the system. The goalie is very important to the team's performance.

1 Introduction

The RoboRoos are one of the longest serving teams in the RoboCup Small Size league. The robots competed at RoboCup '98 [7] where they were runner-up, and in RoboCup '99 [8] where they were eliminated in the quarter finals, despite a 56-1 goal difference during the round robin stage. In RoboCup 2000, the team was eliminated in the semi-finals after a 36 - 2 goal difference in the round robin stage. The field robots have remained mechanically and electronically the same through the years of competition, with significant improvements being made through software revision. The goalkeeper has been re-designed several times over this period with the latest revision detailed in this description.

Figure 1 shows the architecture of the RoboRoos system, which has remained constant since its initial design. The vision system was extensively revised in 1999 with excellent results [9]. The team planning system, MAPS, has been the focus of ongoing development [4,5,6], and represents one of the most significant research results of the RoboRoos development. MAPS forms cooperative strategies by observing team agents at the current point in time and choosing appropriate actions to increase the likelihood of cooperation in the near future. These actions are transmitted to the robots, along with the current state of the field, over the RF communications link. The RF communications link has received significant attention to ensure reliability under adverse conditions. The robots use the information from the communications link to set the current goal for navigation, and to build representations of obstacle maps for path planning. The navigation module for the robots has been another area of significant research effort [2], and provides the smooth controlled motion that is the signature feature of the RoboRoos.

EXAMPLE OF GOOD WRITING

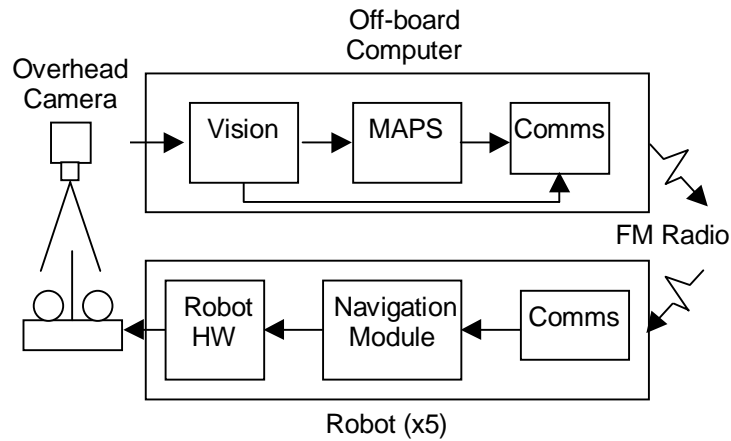


Figure 1: The RoboRoos system in overview showing the key modules and their connectivity.

This team description will focus on the parts of the system that are not described elsewhere, and that have contributed significantly to the team's success in RoboCup 2000 - the new goal keeper design, the communications link and the navigation system. The conclusion focuses on the future of the RoboRoos.