Technical Writing @ SLCC

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DEPARTMENT OF ENGLISH, LINGUISTICS, AND WRITING STUDIES AT SLCC

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Foreword

This textbook is for use in the English 2100 Technical Writing courses at Salt Lake Community College. It contains reading materials that the Technical Writing Committee of the English department have deemed important for students of ENGL 2100 to learn.

It is also prepared for use by the tutors of the Student Writing and Reading Center at SLCC.

Finally we also present this book to everyone at SLCC and the general public as a resource for technical writing.

Introduction to Technical Writing @ SLCC

What is technical writing? You can think of it as writing about specialized topics or you could also think of it as using technology to communicate your ideas.[1] A science lab report, a specification, a change order for building construction, or patient education materials–just to name a few–are all considered technical writing. Similarly if you design a webpage or a brochure this can also be considered technical writing.

Academic writing, the writing you do for school, generally is informative or persuasive writing and usually only comes in a few different genres. In technical writing, on the other hand, one is often documenting what was done (such as a science experiment or auto repair invoice). Therefore the format of the writing is often as important as the content. This leads to an emphasis on usability and accessibility for your documents.

Finally, although citing your sources is important in all writing, you will find that in some fields of technical writing, such as the sciences and engineering, it is one of the more important considerations of your writing.

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1. Society for Technical Communication. 2019. *Defining Technical Communication*. [accessed 2019 Nov. 14]. https://www.stc.org/about-stc/defining-technical-communication.

Engl 2100 Learning Outcomes

The ENGL 2100 Technical Writing course at Salt Lake Community College is designed to help students prepare for writing in STEM and related fields. It is *not* a course designed to prepare students for a career in technical writing.

These learning outcomes describe the goals for the course, ENGL 2100 Technical Writing.

- Students will be able to describe aspects of rhetorical situations including purpose, audience, and context.
- Students will be able to identify and explain rhetorical strategies across different written, digital, and visual documents.
- Students will be able to evaluate the rhetorical effectiveness of written, digital, and visual documents.
- Students will effectively incorporate written, digital, and visual documents into their own writing.
- Students will use multiple composing processes (e.g. planning or preparation [includes audience analysis, genre and medium determination], research, organizing, drafting and/or designing, revision or editing, proofreading) to complete writing tasks.
- Students will produce a variety of written, digital, and/or visual documents for different purposes, audiences, and contexts.
- Students will reflect on themselves as writers.

Tips for Writing Tutors

This textbook is designed to to address certain writing topics that are covered in ENGL 2100 Technical Writing. Each chapter, however, also includes a short section titled, “Tips for Writing Tutors,” that gives suggestions to the tutors on how to help students with the material in that chapter. These tips will point out what is considered the most important for that chapter and problems that students may struggle with.

PART I

THE WRITING PROCESS

One does not have to be born with great writing talent to write a good paper. Rather, good writing comes from good habits. Poor habits, on the other hand, result in poorly written papers. Some poor habits include 1) writing your paper just before the deadline resulting in a rushed paper or 2) skipping one or more of the steps of writing.

Like any other habit it takes time and practice to become a good writer. This chapter introduces six steps of writing and helps you learn how to be a better writer. This chapter is meant to accompany your writing project, but you can follow these steps whenever you need to write whether at school or in the workplace.

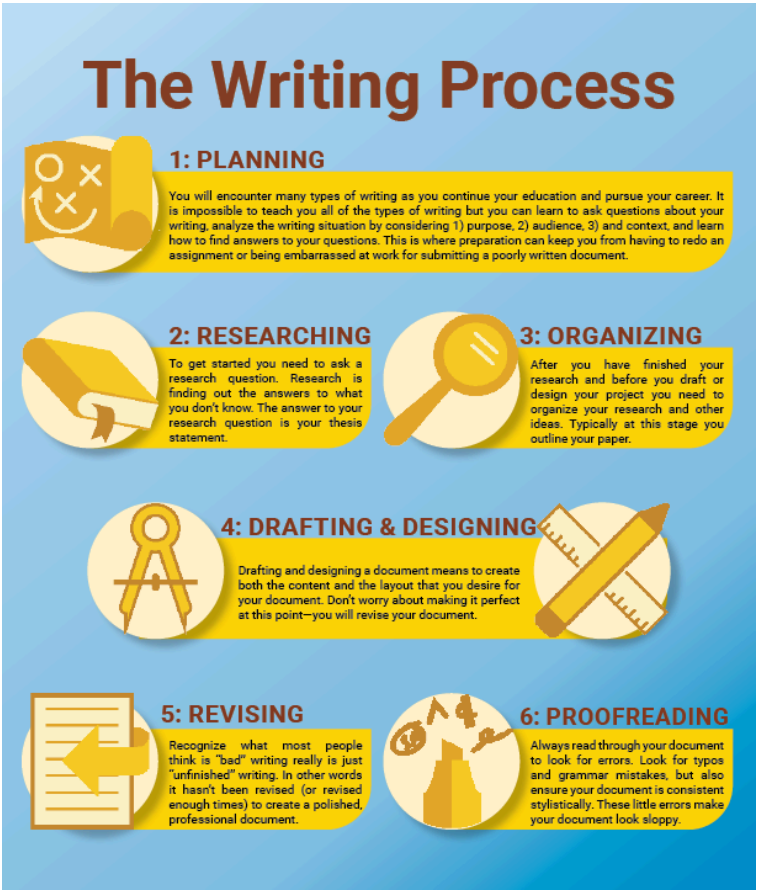

Fig. 1.1. *Brian Powell, Salt Lake Community College 2020. (CC BY-NC 4.0 Attribution NonCommercial.)*

Step 1: Preparation

Ever had the “blank screen” syndrome? That is you didn’t know what to write or how to get started? That is where the step of preparation comes in.

Unfortunately many students skip this part. They rush into research, or if the paper does not require research they skip straight to drafting. Yet spending just a few minutes preparing to write not only helps make a better paper, it saves time in later steps as well.

Write for 5

Here are two ways to start thinking about a topic to write about.

The first is called *freewriting*. Write for a few minutes *without stopping* on whatever comes to mind about a topic. You could set a timer to force yourself to write without stopping. After the time is up reread what you have written and look for the most important idea, richest or most intriguing detail, etc. Then freewrite on this idea or detail you have chosen. This is called *looping* as you keep writing without stopping on each successive idea until you have a good topic for your paper

The second way to start thinking about a topic is simply by making lists. You write down your topic then list ten or so things about that topic; again don’t stop

writing while you make your list. Then look over the list and see if you have a good idea for your paper. If not, pick the one that appeals to you most and make a new list. Keep going until you have an idea for your paper.

There are many other ways to start thinking about how to write besides the two listed in the above Write for 5. For example there are the journalists' questions that you could ask about your topic: who, what, why, where, when, how? Or going back to Aristotle you can define (what is it?), compare (what is it like or not like?), understand relationships (what caused it?), understand circumstances (what is possible or impossible about it?), or even seek testimony about it (what have others said about it?).

You will encounter many types of writing as you continue your education and pursue your career. It is impossible to teach you all of the types of writing but you can learn to ask questions about your writing, analyze the writing situation by considering 1) purpose, 2) audience, 3) and context, and knowing how to find answers to your questions. This is where preparation can keep you from having to redo an assignment or being embarrassed at work for submitting a poorly written document. The next three pages teach you about using preparation to plan your purpose, audience, and context.

Step 1 Continued: Planning with Purpose

What is the purpose of your document? Is it already defined by the assignment or by needs of your workplace or client? Often the purpose is already known–a professor will give you the assignment and explain the not only the purpose but the requirements for the assignment. Or perhaps you need to create advertising to attract clients.

If the purpose is not already defined then you need to determine the purpose yourself. To do this you need to understand your audience and the context for the document.

Step 1 Continued: Planning based on your Audience

Who is your audience? Answering this question determines much of what you write, why you write, and how you write it. For example if you audience is already an expert in the subject you don't need to include background information or define special technical terms like you would with a general audience.

Write for 5

Think about your audience. Are they experts in the subject or are they beginners. Are you writing for an executive, co-worker, or client? Is your audience adult or teens or children? What language do they speak? Write down as many characteristics as you can think of to describe your audience.

Step 1 Continued: Planning based on Context

Context can refer to several different things. First, how will your audience use your technical document? Does it need to be printed, or an e-document? Should it even be a document or would a video or audio recording be better?

Another way to think of context is to consider what will influence your audience as they read your document. Are there political, cultural, or even environmental considerations that you need to think about. For example, if you look at a Japanese map of a city a swastika marks the location of a Buddhist temple. But it would be considered offensive to use a swastika in a document meant for a Jewish audience.

Write for 5

Think about your audience and the context that they will use your document. How does this influence your decision of what type of document to create? What else do you need to consider for context?

After you have planned out your purpose, audience, and context, then you need to plan your project calendar.

Step 1 Continued: Planning with a Project Calendar

One of the most important parts of planning to write a document is creating a project calendar. The calendar helps you move through each of the six steps of writing in a timely manner.

Begin by using backward planning. In other words you start with the date that the project (document) is due. Then you build in due dates for each of the steps of writing by going backwards: proofreading, revising, drafting, organizing, researching, etc.

For larger projects you may wish to use a Gantt chart to see how multiple deadlines interact with each other.

If it is a group project then you can use project management software such Asana, Microsoft Project, Clarizen, Wrike, DaPulse, and a host of others to help keep your project on time.

For more information see the chapter on Project Planning.

Step 2: Research

To get started you need to ask a research question. Research is finding out the answers to what you don't know. The answer to your research question is your thesis statement for your research paper. Start by finding your focus: what is it you are looking for or what questions are you trying to answer? Then consider how your purpose will affect your research. Are you trying to persuade your audience or to inform them?

Fig. 1.2. *Brian Powell, Salt Lake Community College 2020. (CC BY-NC 4.0 Attribution NonCommercial.)*

After you have determined your question and before you begin your research think abut what kinds of research do you need to do. One way to do this is by using a mind-map such as in Fig. 1.3:

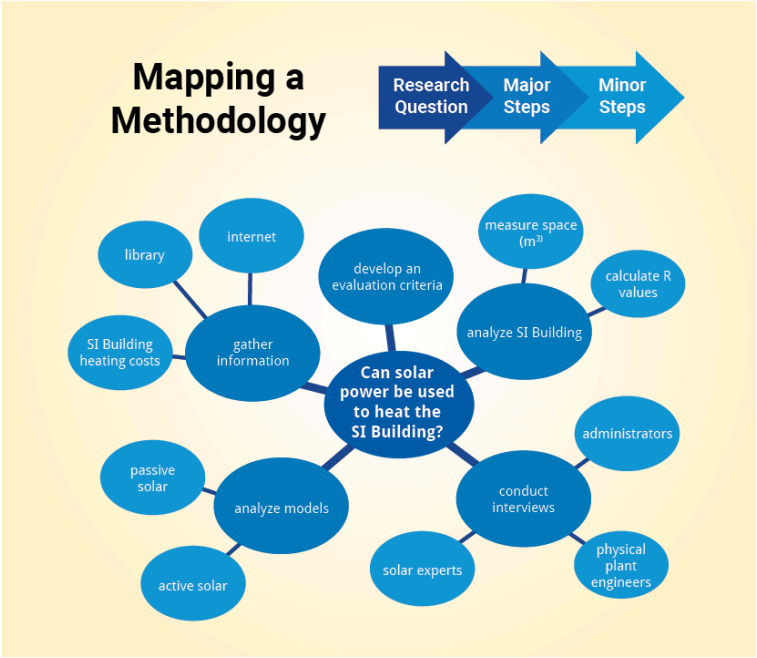

Fig. 1.3 *Brian Powell, Salt Lake Community College 2020. (CC BY-NC 4.0 Attribution NonCommercial.)*

In this mind map the person wants to know whether or not solar power can be used to heat the Science and Industry Building. The major steps indicate ways to determine if it is feasible. The minor steps are things to be researched to answer the question. Thinking about your research methodology even before you start your research will help you do better research and better present the information once the research is finished.

Step 2 Research Continued: Evaluating Your Research

It may seem that research is the easy part: type in a few keywords in to a search engine and the internet returns more than enough information to create your document. But really that is the *problem*–there is too much information and much of it is unreliable.

Part of doing research is finding *credible* sources that you can use for your writing. How do you know it is credible. There are two important steps to determining the credibility of a source: 1) you must be able to evaluation the information you find and 2) you must be able to evaluate your own research process.

Evaluating Information

Ask yourself what source would be credible? If you want to study civil engineering Facebook is not a good source. But if you are studying social interactions of people, maybe Facebook is a good source of information. Given the large amount of information available to research you must manage the information you have with purpose and intent.

- Ask about the author's credibility. If it is an website gives information on cold fusion, is the information written by a physics professor or from someone who is being sued for fraud?
- Check for objectivity. If a university publishes a study

about a pharmaceutical drug touting how great it is but at the same time the company that produced the drug studied is giving a large grant to that university, then you could question the university's objectivity.

Evaluating your own research process

In order to be both *credible* and *ethical* you need to have multiple sources, and often multiple types of sources. Always write down quotations exactly and note the bibliographic information of the source. Review *Technical Writing* chapter 4 "Information Literacy" for more information.

Types of research

- Look-up searching: find immediate information to answer a question such as when you use Google maps, or are looking at one source such as Wikipedia to answer a question.
- Exploratory searching: finding multiple sources, multiple types of sources, or researching multiple viewpoints.
- Primary source: original information such as eyewitness account, data from experiments, novels, diaries, etc.
- Secondary source: sources that provide synthesis or analysis of the information of primary sources.
- Field research: interviews, surveys, etc. Please note if you are conducting field research then certain guidelines apply:
    - Typically, IRB (Institutional Review Board) approval is not required when data collection and analysis is solely for use in the classroom. There are some exceptions to this guideline: IRB approval is needed 1)

if a student wishes to publish or present their findings to a wider audience, 2) if the survey/interview deals with sensitive information, or poses more than minimal risk to participants or 3) if the participants are members of a protected group (like minors).

- In the absence of the IRB, the instructor should take on the responsibility of ensuring the research is conducted ethically, and educating student about protecting human subjects.

Step 3: Organizing with Outlines

After you have finished your research and before you draft or design your project you need to organize your research and other ideas. Typically at this stage you outline your paper.

First review *Technical Writing* chapter 7 "Outlines." Then begin to organize your research and other ideas. As you learned in chapter 7 begin with the big ideas and then work towards making a more detailed outline. We recommend that you write a detailed enough outline that you list the topic of every paragraph you plan on writing in your paper. Any quotations or sources that you plan on using should also included in your outline to make it easier to draft your document.

If you are unsure what structure your outline should take, then think about what format your paper should be in. You could look at *Technical Writing* chapter 10 "Technical Reports" to see the basic format. Or if you are writing in the sciences you can look through the chapter, "Introduction to writing in the sciences" included in this textbook to learn the IMRaD format.

If you are designing a document such as a website or a video an outline still is useful. If you have a website you will want to make a preliminary sketch of the layout and consider where you will place the content. If you are making a video then you will want to sketch out a storyboard showing the sequence of shots, accompanying dialogue, etc. so that you are prepared to make the video. Organizing your information and planning out your document is an important and time-saving step in writing or designing.

For further information on outlines see Purdue OWL "How to Outline." Also explore the topics related to outlining on the left hand menu of Purdue OWL.

Step 4: Drafting and Designing

Drafting

Drafting is often where people start their writing process. But this is step 4! The writing will go much smoother if you first complete the other three steps and you will have a much better document.

Once you have completed steps 1-3 then you are finally ready to begin drafting your document. Follow the outline you have made. If your outline matches the structure of the document you are drafting then it will be even easier to write.

In writing paragraphs it is recommended that you follow the old-new method (sometimes called the known-new method).

There are certain rhetorical strategies we use in drafting technical writing documents. These are called Rhetorical Methods of Development, which is a fancy way of saying these are common patterns of organization that you can use to present information.

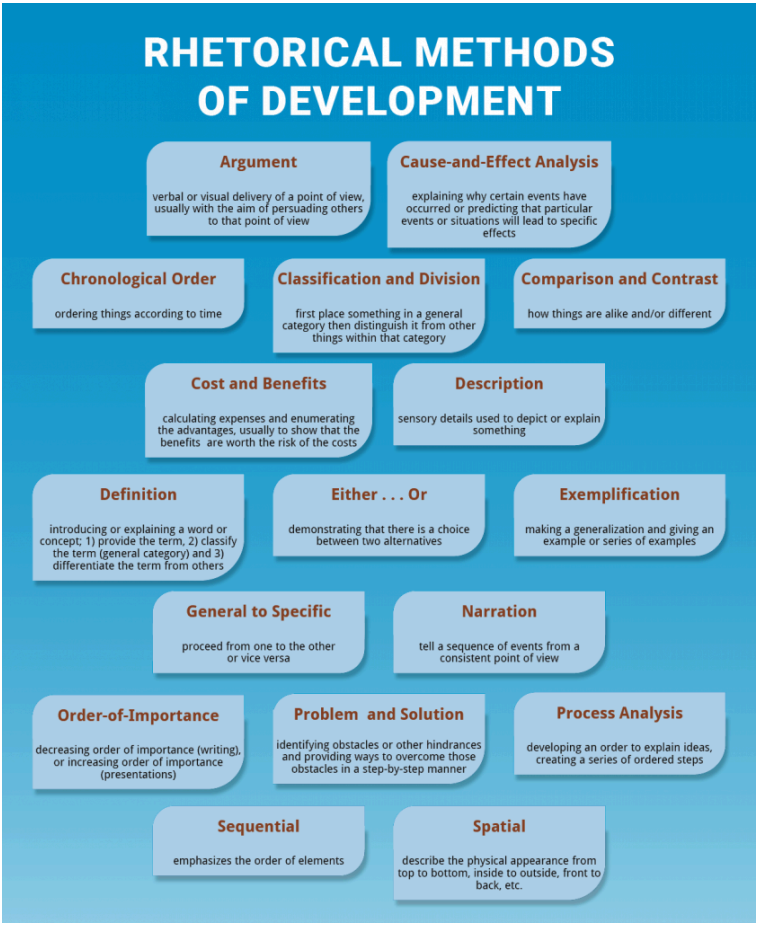

Fig. 1.4. Brian Powell, SLCC 2020. (CC BY-NC 4.0 Attribution NonCommercial.)

Designing

You will also want to design your draft. For a document that is primarily text this may simply be selecting headings and formatting paragraphs and fonts. If the document is

multimodal, multimedia, or in some other way emphasizes design then you will need to spend more time thinking at this stage about the layout or storyboard of your document. For example if it is a poster, what should the layout look like? Or for a video, you will need to plan or storyboard the scenes as part of design.

Step 5: Revising (or Editing)

> *"They have accepted the grim reality that nine-tenths of all writing is rewriting. . ."* [1].

Recognize what most people think is "bad" writing really is just "unfinished" writing. In other words it hasn't been revised (or revised enough times) to create a polished, professional document.

Although the words revising and editing are often used to refer to the same thing, rewriting your first and subsequent drafts, in the publishing world revising is what the writer does and editing is, well what an editor does. The writer revises until they are satisfied and sends it to the editor (there are multiple kinds of editors, here we will simplify it to just the editor) who "edits" by checking for structure, style, grammar, spelling, and other problems. The editor may work closely with the writer or they may work separately sending each draft back and forth until both are satisfied.

If it is not a formal publication then really it doesn't matter what you call it, revising or editing, so long as you go through the various tasks of rewriting your work.

Here are some things to check for when revising:

- checking the main ideas
    - does the organization of those ideas make sense?
    - is there enough information to explain/ support the ideas?
    - is there too much or irrelevant information that should be cut out?
- does the introduction:
    - clearly explain the Purpose of document
    - Clearly identify the subject?
    - Clear thesis, claim or hypothesis?
- Body
    - Sentences: subject easy to locate and use of action verbs
    - Does each paragraph have a clear topic (claim) sentence and enough support?
    - Check for transitions between paragraphs
    - Good paragraph organization (given/new)
    - Overall flow of presentation of information or argument
    - check for fallacies–illogical, irrelevant, or unsupported statements
- Conclusion:
    - Restate main point?
    - Emphasize the importance of subject?
    - Look to future?
- Design

    - It the document layout simple and easy to navigate?
    - Titles, headings, subheadings to help guide the reader?
    - Graphics support text and clarify difficult points?
    - Check all quotations, paraphrases properly framed and correctly cited
    - Fact-check
- Style conform to the standards of your major?
    - consistent use of formal writing
    - concise and clear writing
- Make sure bibliography is properly formatted

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[1] Trimble, John R. 2000. *Writing with Style: Conversations on the Art of Writing*. 2nd ed. Prentice Hall. P. 9.

Step 6: Proofreading

In publishing after an author is finished revising and all the edits by the publisher have been made, a set of proofs is created. The proofs show how the document will look when printed. At this point someone reads the proofs to catch any missed errors–hence the term proofreading.

You should be in the habit of proofreading all your professional documents, whether emails, memos, proposals, reports, websites, videos, etc. Always read through or look over (or listen or watch) your document to look for those missed errors. Often a simply typo or a mistake in grammar, but sometimes a stylistic error such as missing page numbers or a change in font partway through the document these little errors make your document look sloppy.

Taking the time to proofread is simply being professional in the way you approach your work, including communication.

1. References

Carnegie Mellon University Global Communication Center Resources. 2020. [Accessed 26 Sep 2020] https://www.cmu.edu/gcc/handouts-and-resources/

Purdue Online Writing Lab. 2020. [Accessed 26 Sep 2020] https://owl.purdue.edu/index.html

Tips for Writing Tutors

It is easy while helping students to focus just on one aspect of their document. However, helping them understand writing is a process rather than an event and that good writing requires revision is important.

PART II

INTRODUCTION TO WRITING IN THE SCIENCES

Prepared for ENGL 2100 Technical Writing at Salt Lake Community College by Daniel D. Baird (English Department faculty) and Stella G. Mosher (coordinator for DUMKE STEM Center and adjunct faculty in the Geoscience Department). Reviewed by Benjamin Solomon (English Department faculty).

1 Overview

What is writing in the sciences and how does it differ from other types of writing? The simplest answer is that it is writing done in the various branches of science such as astronomy, biology, chemistry, geology, oceanography, physics, health sciences, etc. More specifically within the sciences, *scientific writing* is contrasted with *science writing*. *Scientific writing* is writing that conveys information about one's own research to other scientists. In contrast, *science writing* is writing about science for the general public or for popular media (Sheffield 2011). Regardless of whether you are writing for other scientists or the general public, there are a few key ways in which writing in the sciences differs from writing in the humanities or any other discipline. Writing in the sciences includes concision. Concision refers to eliminating unnecessary words without omitting important information. Writing in the sciences also means that you adhere to a methodology: a systematic and reproducible approach to conducting research. Finally it focuses on the sharing of research. This document is to help you learn a little about the rhetoric of science—what to expect when you are reading scientific articles and how to use these rhetorical strategies in your own writing.

The structure of a scientific article will usually be "some variation on the IMRAD form along with a references section. . ." (CSE 2014, 4). IMRAD stands for Introduction, Methodology, Research, and Discussion (of research). This is a very different structure of writing compared to that typically used outside of science and you may be unfamiliar with it. With a little practice, however, you will soon be able to confidently use this structure. "This so-called 'IMRAD' structure is not an arbitrary publication format but rather a direct reflection of the process of scientific discovery. Long articles may need subheadings within some

sections (especially Results and Discussion) to clarify their content" (Intl. Committee of Medical Journal Editors 2010). In order to help you understand this important format the majority of the following chapters are spent introducing you to this structure.

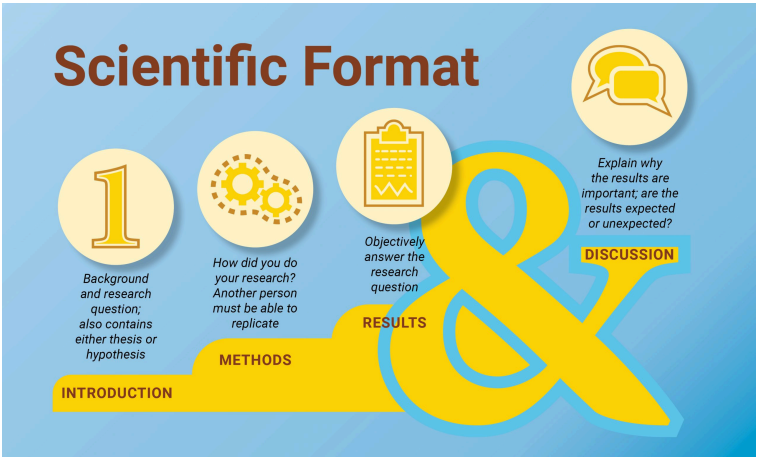


Fig. 2.1. *Brian Powell, Salt Lake Community College 2020. (CC BY-NC 4.0 Attribution NonCommercial.)*

In addition to the overview of the scientific structure, you will be introduced to the literature review. Whether a stand-alone document or as part of a larger document the literature review is an important genre in the sciences.

Throughout this chapter we have used a published scientific paper for examples of the ideas you are learning. The language of the paper may seem difficult but pay attention to the concepts pointed out in each example so that you can learn to recognize and eventually learn how to use these concepts in your own writing.

There is also a section on references. This is not meant to be a comprehensive guide to the correct way to cite your sources in

the sciences, but rather a brief overview since what you learned previously may not be the way it is done in the sciences.

Finally this document is meant to be an introduction only. Your instructor's or a publisher's requirements always supersede what is written in this textbook.

Writing tip: The headings, heading numbers, and other formatting used in this document follow the recommended style for a scientific paper based on *Scientific Style and Format: The CSE Manual for Authors, Editors, and Publishers* created by the Council of Science Editors (8th edition), referred to as CSE in this chapter.

2 Front Matter

Front matter is all the information that is placed at the beginning of the document. It includes the title of the document, name of the author(s), and date of publication. See Fig. 2.2 below for an example of front matter.

2.1 Title

Titles are to be concise as possible yet still convey the information to the reader as to the topic of the document. In science titles are straightforward and simply describe the focus of the research or experiment; avoid the poetic or clever. Also avoid acronyms or shortening of scientific terms. Finally avoid roman numerals as they are confusing in searches.

2.2 Author(s)

The *byline* lists the authors of the article. Sometimes it is an organization, rather than individuals that are listed as responsible for a publication. Often journals also have an author statement located in the back matter that credits the role of each author such as who participated in research, writing, revising, etc.

2.3 Author Affiliation

A document usually also includes institutional affiliation of the author(s) allowing one to contact the author(s).

Writing tip: for your document use your instructor's name and class. For example: Professor Smith, Biology 1030.

2.4 Date

The date will not always be listed on the article title page as it may have already been listed on the title page of the journal. Sometimes it is found in either the header or footer of the pages in the journal.

Writing tip: for your document always place the date on your title page and it should be the date you submitted your paper.

2.5 Abstract

It is common for all scientific publications to have an abstract. "[A]n abstract should be published with every journal article, essay, and discussion. An abstract helps readers to decide whether the article is of interest; as such, its content must reflect the content of the article as closely as possible, within the length available" (CSE 2014, 4). The abstract helps one make a decision as to whether or not the article is relevant to one's research, or even one's general interest. Abstracts generally run between 100 and 250 words although journals may require shorter or longer abstracts. Abstracts generally include purpose, methods, important or key results, and main conclusions.

An article may also request a graphical abstract. It generally consists of a single image and like the written abstract gives the reader a quick overview of the contents of the article. The image may be a diagram or an infographic.

Writing tip: here are some things to consider when writing your abstract:

Do:

- State research objectives
- Explain the "what" and the "why" of the research
- Briefly describe methods
- Summarize important results
- State main conclusions and significance

Don't:

- Use quotations, references, or figure citations
- Present information not included in the report
- Get bogged down by the details

2.6 Keywords

Often a short list of words is included after the abstract to help readers search for the document. These keywords are

descriptors of the main ideas of the document. Generally these are not the same as those used in the title.

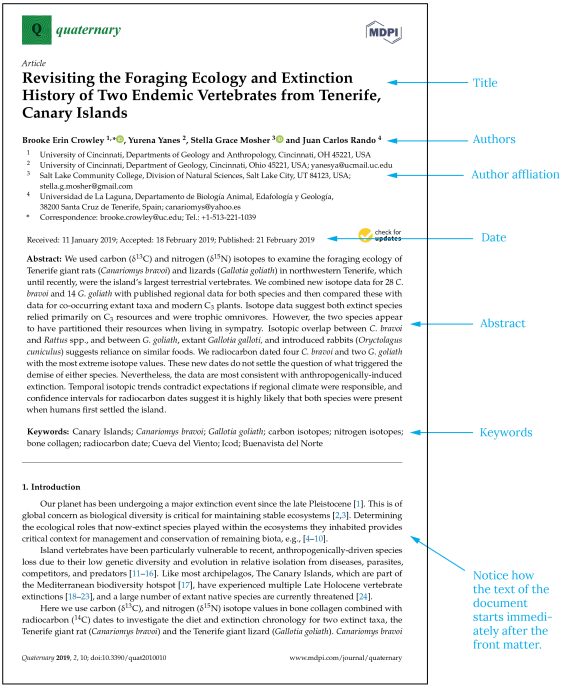


***Fig. 2.2**. Front matter of an article. Source: Crowley et. al. 2019. (CC: By 4.0.)*

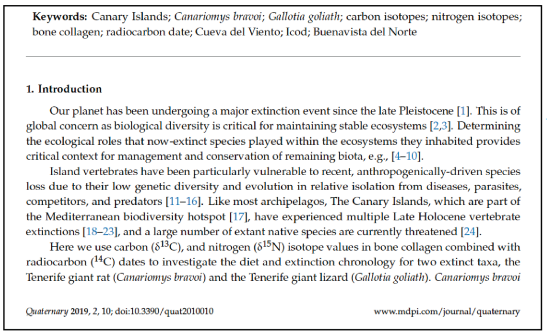
3 Writing an Introduction

An introduction gives the reader the "why" the document was written. It provides readers important context for understanding your writing. For example, what was the research question or experiment that led to the creation of the written document? In general it will contain a statement of purpose, a hypothesis or thesis, and define the scope of the document—what it is or is not about. Of course there will be background information, but how much or how little will depend on the audience. A specialist in your field will need less background information than a general audience.

In science documents, the introduction often follows what is known as the Creating a Research Space (CARS) rhetorical pattern (Swales 2012). There are three sections or moves in a CARS: 1) Establishing a Territory, 2) Establishing a Niche, and finally 3) Occupying the Niche.

3.1 Establishing a territory

Establishing your territory is like announcing your topic to your readers. You also want to explain to the readers that your paper is important. To do this first you need to do more than just announce the topic, you need to give some context to your topic. Put your research or experiment into a wider context either by giving a general overview of the of the topic or by reviewing previous research. Reviewing previous research is called a literature review and is very important in writing in the sciences. See section 9 for more information on the literature review. See Fig. 2.3 for an example of establishing your territory.



Keywords: Canary Islands; *Canariomys bravoi*; *Gallotia goliath*; carbon isotopes; nitrogen isotopes; bone collagen; radiocarbon date; Cueva del Viento; Icod; Buenavista del Norte

1. Introduction

Our planet has been undergoing a major extinction event since the late Pleistocene [1]. This is of global concern as biological diversity is critical for maintaining stable ecosystems [2,3]. Determining the ecological roles that now-extinct species played within the ecosystems they inhabited provides critical context for management and conservation of remaining biota, e.g., [4–10].

Island vertebrates have been particularly vulnerable to recent, anthropogenically-driven species loss due to their low genetic diversity and evolution in relative isolation from diseases, parasites, competitors, and predators [11–16]. Like most archipelagos, The Canary Islands, which are part of the Mediterranean biodiversity hotspot [17], have experienced multiple Late Holocene vertebrate extinctions [18–23], and a large number of extant native species are currently threatened [24].

Here we use carbon ($\delta^{13}C$), and nitrogen ($\delta^{15}N$) isotope values in bone collagen combined with radiocarbon (^{14}C) dates to investigate the diet and extinction chronology for two extinct taxa, the Tenerife giant rat (*Canariomys bravoi*) and the Tenerife giant lizard (*Gallotia goliath*). *Canariomys bravoi*

Quaternary 2019, *2*, 10; doi:10.3390/quat2010010 www.mdpi.com/journal/quaternary

The authors begin with a general overview of the topic.

***Fig. 2.3**. Introduction: Establishing a territory. Source: Crowley et al. 2019. (CC: BY 4.0.)*

3.2 Establishing a Niche

A niche is the specific research question or topic that your document addresses. In the example paper by Crowley et. al. (2019), the general topic is the extinction of vertebrate animals living on islands (Fig. 2.4). The niche, or specific topic, is the extinction history of a particular giant rat and a giant lizard in the Canary Islands.

When establishing your niche ask what is missing from previous research. Is there a gap or something that needs more research or verification? Also include briefly what methods of analysis are used for testing, validation, etc.

Writing tip: make a clear argument for the value of your particular research; e.g., what are the gaps in research that your study addresses?

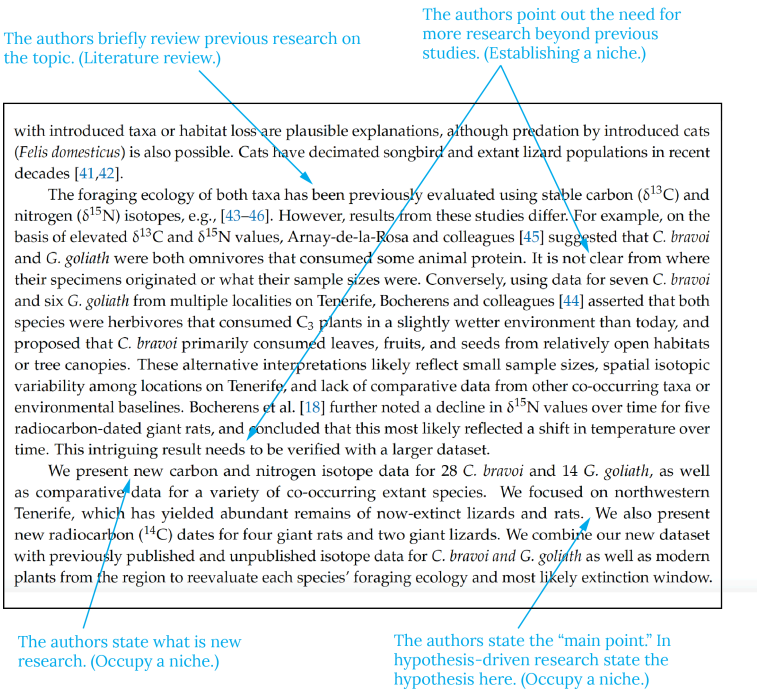


***Fig. 2.4**. Introduction: Literature Review, establishing a niche, and occupying a niche. Source: Crowley et al. 2019. (CC: BY 4.0)*

3.3 Occupying the Niche

Here you announce how your study will contribute new knowledge or verify previous knowledge. You also state your hypothesis or thesis in this part of the introduction. Make clear the links between problem and solution, question asked and research design, prior research and your experiment.

Finally describe the organizational structure of the paper. (See Fig. 2.4.)

Writing tip: here are some ways to occupy your niche (notice all of these prompts are in present tense):

- The aim of this paper is

- My main purpose is
- My primary objective is
- This paper reports on the results of
- This paper primarily focuses on

When occupying your niche you can state either your thesis or hypothesis. A thesis is a statement or claim that you make about a subject and tells the reader your viewpoint. A hypothesis, on the other hand, is a tentative answer to a question, one that must be tested through experimentation.

4 Writing the Materials and Methods (Methodology) Section

The Materials and Methods section briefly describes how you did your research. In other words, what did you do to answer your research question? If there were materials used for the research or materials experimented on you list them in this section. You also describe how you did the research or experiment. The key to a methodology is that another person must be able to replicate your research—follow the steps you take. For example if you used the internet to do a search it is not enough to say you "searched the internet." A reader would need to know which search engine and what key words you used.

Open this section by describing the overall approach you took or the materials used. Then describe to the readers step-by-step the methods you used including any data analysis performed. See Fig. 2.5 below for an example of materials and methods section.

Writing tips:

Do:

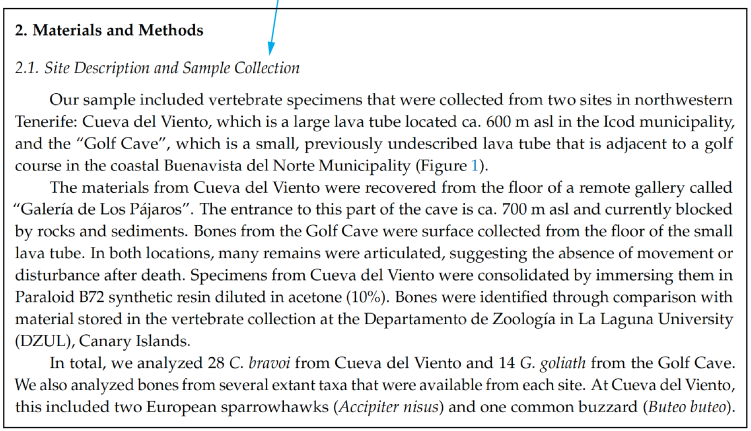
- Explain procedures, materials, and equipment used
- Provide enough detail for replication!
    - Example: "We used an x-ray fluorescence spectrometer to analyze major and trace elements in the mystery mineral samples."
- Order events chronologically, perhaps with subheadings (Field work, Lab Analysis, Statistical Models)
- Use past tense (you did X, Y, Z)

- Quantify measurements

Don't:

- Include results in the methods! It's easy to make this mistake!
- List unnecessary details; i.e., if someone could look up how to operate an instrument, you do not need to explain how to use that instrument.
    - Example: "We turned on the machine and loaded in our samples, then calibrated the instrument and pushed the start button and waited one hour. . . ."

The authors describe the samples that were analyzed as well as the places the samples were collected.



2. Materials and Methods

2.1. Site Description and Sample Collection

Our sample included vertebrate specimens that were collected from two sites in northwestern Tenerife: Cueva del Viento, which is a large lava tube located ca. 600 m asl in the Icod municipality, and the "Golf Cave", which is a small, previously undescribed lava tube that is adjacent to a golf course in the coastal Buenavista del Norte Municipality (Figure 1).

The materials from Cueva del Viento were recovered from the floor of a remote gallery called "Galería de Los Pájaros". The entrance to this part of the cave is ca. 700 m asl and currently blocked by rocks and sediments. Bones from the Golf Cave were surface collected from the floor of the small lava tube. In both locations, many remains were articulated, suggesting the absence of movement or disturbance after death. Specimens from Cueva del Viento were consolidated by immersing them in Paraloid B72 synthetic resin diluted in acetone (10%). Bones were identified through comparison with material stored in the vertebrate collection at the Departamento de Zoología in La Laguna University (DZUL), Canary Islands.

In total, we analyzed 28 *C. bravoi* from Cueva del Viento and 14 *G. goliath* from the Golf Cave. We also analyzed bones from several extant taxa that were available from each site. At Cueva del Viento, this included two European sparrowhawks (*Accipiter nisus*) and one common buzzard (*Buteo buteo*).

Fig. 2.5. Methods including a subheading. Source: Crowley et al. 2019. (CC: BY 4.0.)

5 Writing the Results Section

5.1 The Results Section

This section explains what you found; i.e., the answer to your research question. The Results and the Discussion (of the results) sections are the two most often mixed up sections by those who are new to this structure of writing. Just remember that Results is where you objectively summarize and present the data.

Generally, this section will begin with a brief overview of the results, then cover each of the main results from the data. Objectively point out the main ideas and use tables, figures, and other graphics as necessary to present the data. This section also discusses any limitations of the study. Fig. 2.6 shows an example of the Results section.

Writing tips:

If you are writing a purely research paper you can present your findings using verbs of attribution: words that point out that these are someone else's ideas. For example, you could write:

- The author stated
- This article points out
- We found
- The results of the PCR analysis showed that
- Model results can be seen in Table X

Just remember not to interpret the information. For writing an experimental report here are some tips:

Do:

- Report results and show supporting data
- Order results from most to least complex
- Describe results in past tense
- Be concise: Examining patterns for 38,646 measurements of foliar $\delta^{15}N$ from non-N^2-fixing species, mean foliar $\delta^{15}N$ was 0.4‰ (Table 1).

Don't:

- Interpret results
- Repeat all the data from the table, instead select important results to report
- Be verbose: Table 1 indicates that after examining patterns for 38,646 measurements of foliar $\delta^{15}N$ from non-N^2-fixing species the mean foliar $\delta^{15}N$ was 0.4‰.

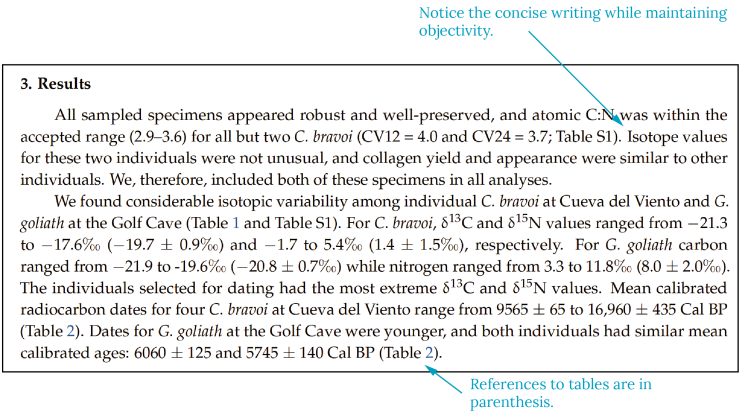


Fig. 2.6. *Example of Results section. Source: Crowley et al. 2019. (CC: BY 4.0.)*

5.2 Figures and Tables

The word figure is used to describe any graphic in the document that is not a table. It can refer to photographs,

drawings, diagrams, maps, and other type of illustrations. Fig. 2.7 shows a table and Fig. 2.8 shows results with a figure.

Writing Tips:

Be consistent in formatting for all figures and tables. Figure numbers and titles are listed in the caption below the figure. Table numbers and titles are listed above the table. Notes or source information are placed in the caption below the table. Figures and tables should be placed in the text where they are referred to and the reference to the figure or table should be in parenthetical text. Captions should be concise yet contain enough information for the reader to understand what the figure is about. Graphs should have clearly labeled legends.

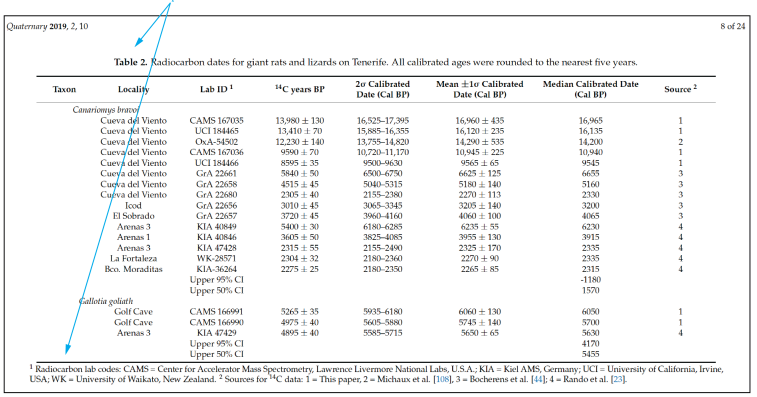


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Table 2. Radiocarbon dates for giant rats and lizards on Tenerife. All calibrated ages were rounded to the nearest five years.

Taxon	Locality	Lab ID [1]	^{14}C years BP	2σ Calibrated Date (Cal BP)	Mean ±1σ Calibrated Date (Cal BP)	Median Calibrated Date (Cal BP)	Source [2]
Canariomys bravoi							
	Cueva del Viento	CAMS 167035	13,980 ± 130	16,525–17,395	16,960 ± 435	16,965	1
	Cueva del Viento	UCI 184465	13,410 ± 70	15,885–16,355	16,120 ± 235	16,135	1
	Cueva del Viento	OxA-54502	12,230 ± 140	13,755–14,820	14,290 ± 535	14,200	2
	Cueva del Viento	CAMS 167036	9590 ± 70	10,720–11,170	10,945 ± 225	10,940	1
	Cueva del Viento	UCI 184466	8595 ± 35	9500–9630	9565 ± 65	9545	1
	Cueva del Viento	GrA 22661	5840 ± 50	6500–6750	6625 ± 125	6655	3
	Cueva del Viento	GrA 22658	4515 ± 45	5040–5315	5180 ± 140	5160	3
	Cueva del Viento	GrA 22680	2305 ± 40	2155–2380	2270 ± 113	2330	3
	Icod	GrA 22656	3010 ± 45	3065–3345	3205 ± 140	3200	3
	El Sobrado	GrA 22657	3720 ± 45	3960–4160	4060 ± 100	4065	3
	Arenas 3	KIA 40849	5400 ± 30	6180–6285	6235 ± 55	6230	4
	Arenas 1	KIA 40846	3605 ± 50	3825–4085	3955 ± 130	3915	4
	Arenas 3	KIA 47428	2315 ± 55	2155–2490	2325 ± 170	2335	4
	La Fortaleza	WK-28571	2304 ± 32	2180–2360	2270 ± 90	2335	4
	Bco. Moraditas	KIA-36264	2275 ± 25	2180–2350	2265 ± 85	2315	4
		Upper 95% CI				-1180	
		Upper 50% CI				1570	
Gallotia goliath							
	Golf Cave	CAMS 166991	5265 ± 35	5935–6180	6060 ± 130	6050	1
	Golf Cave	CAMS 166990	4975 ± 40	5605–5880	5745 ± 140	5700	1
	Arenas 3	KIA 47429	4895 ± 40	5585–5715	5650 ± 65	5630	4
		Upper 95% CI				4170	
		Upper 50% CI				5455	

[1] Radiocarbon lab codes: CAMS = Center for Accelerator Mass Spectrometry, Lawrence Livermore National Labs, U.S.A.; KIA = Kiel AMS, Germany; UCI = University of California, Irvine, USA; WK = University of Waikato, New Zealand. [2] Sources for ^{14}C data: 1 = This paper, 2 = Michaux et al. [108], 3 = Bocherens et al. [44]; 4 = Rando et al. [23].

Fig. 2.7. *Example of a Table. Source: Crowley et al. 2019. (CC: BY 4.0)*

3.1. Icod Region

There were no differences in median $\delta^{13}C$ or $\delta^{15}N$ values among the 28 *C. bravoi* individuals analyzed in this study and the six individuals previously analyzed by Bocherens and colleagues [44] from other sites in the Icod Region (Kruskal–Wallis $p > 0.05$; Table 1, Figure 2). Carbon isotope values were significantly more variable for individuals from this study (Bartlett $p = 0.026$; Table 1, Figure 2), while $\delta^{15}N$ values were significantly more variable for the three previously analyzed individuals from Cueva del Viento (Bartlett $p = 0.0048$; Table 1, Figure 2). We included all individuals in our analysis because there is nothing concerning about any of the data and they are biologically meaningful. Differences in variance among groups could reflect local variability in food resources, microhabitat, or temporal trends. The overall ranges in $\delta^{13}C$ and $\delta^{15}N$ values exhibited by *Canariomys* in the Icod region were −21.3 to −18.6‰ (−19.8 ± 0.7‰) and −1.7 to 7.4‰ (1.5 ± 1.7‰), respectively (Figure 2). Predatory birds had similar $\delta^{13}C$ values ($p > 0.05$) and significantly higher $\delta^{15}N$ values than *Canariomys* ($\chi^2 = 2.73$, df = 2, $p = 0.0204$; Table 1, Figure 2).

In the text a figure is referred to in parenthesis.

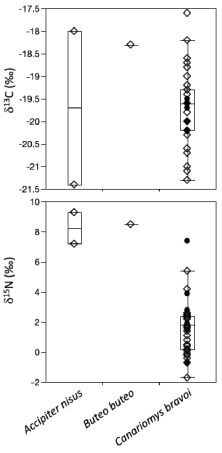


Figure number and description are part of the caption below the figure.

Figure 2. Boxplots comparing $\delta^{13}C$ and $\delta^{15}N$ values for taxa at Icod. Boxes represent 25 and 75‰ quartiles, and whiskers contain 1.5 times the interquartile range. Diamond symbols indicate the specimens analyzed in this study.

***Fig. 2.8**. A page in the Results section showing a figure with caption. Source: Crowley et al. 2019. (CC: BY 4.0)*

6 Writing the Discussion and Conclusion Sections

6.1 Discussion

This section discusses your results, presenting the "so what," or "why should the reader care" about your research. This is where you explain what you think the results show. Tell the reader the significance of your document by discussing how the results fit with what is already known as you discussed in your introduction, how the results compare with what is expected, or why are there unexpected results. Here are some words to get you thinking about this section: evaluate, interpret, examine, qualify, etc.

Start by either summarizing the the information in this section or by stating the validity of the hypothesis. This allows readers to see upfront your interpretation of the data. End the discussion by summarizing why the results matter.

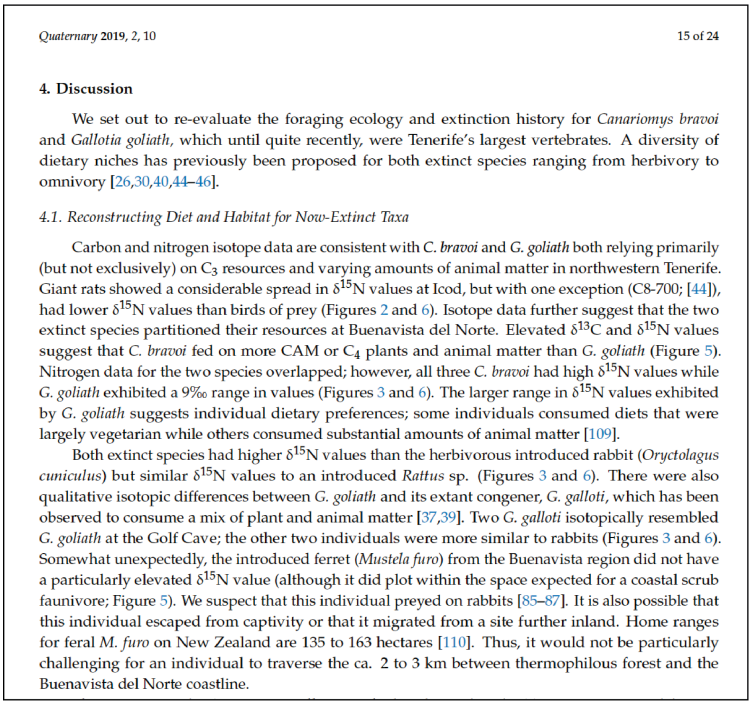
Writing tips:

Do:

- Summarize the most important findings at the beginning (1-3 sentences)
- Describe patterns and relationships shown in your results
- Explain how results relate to expectations and literature cited in Introduction
- Explain contradictions and exceptions
- Describe need for future research (if no Conclusion section)

Don't:

- Overgeneralize, use specific supported statements
- Ignore unexpected results or deviations from your data
- Speculate conclusions that cannot be tested in the foreseeable future.



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4. Discussion

We set out to re-evaluate the foraging ecology and extinction history for *Canariomys bravoi* and *Gallotia goliath*, which until quite recently, were Tenerife's largest vertebrates. A diversity of dietary niches has previously been proposed for both extinct species ranging from herbivory to omnivory [26,30,40,44–46].

4.1. Reconstructing Diet and Habitat for Now-Extinct Taxa

Carbon and nitrogen isotope data are consistent with *C. bravoi* and *G. goliath* both relying primarily (but not exclusively) on C_3 resources and varying amounts of animal matter in northwestern Tenerife. Giant rats showed a considerable spread in $\delta^{15}N$ values at Icod, but with one exception (C8-700; [44]), had lower $\delta^{15}N$ values than birds of prey (Figures 2 and 6). Isotope data further suggest that the two extinct species partitioned their resources at Buenavista del Norte. Elevated $\delta^{13}C$ and $\delta^{15}N$ values suggest that *C. bravoi* fed on more CAM or C_4 plants and animal matter than *G. goliath* (Figure 5). Nitrogen data for the two species overlapped; however, all three *C. bravoi* had high $\delta^{15}N$ values while *G. goliath* exhibited a 9‰ range in values (Figures 3 and 6). The larger range in $\delta^{15}N$ values exhibited by *G. goliath* suggests individual dietary preferences; some individuals consumed diets that were largely vegetarian while others consumed substantial amounts of animal matter [109].

Both extinct species had higher $\delta^{15}N$ values than the herbivorous introduced rabbit (*Oryctolagus cuniculus*) but similar $\delta^{15}N$ values to an introduced *Rattus* sp. (Figures 3 and 6). There were also qualitative isotopic differences between *G. goliath* and its extant congener, *G. galloti*, which has been observed to consume a mix of plant and animal matter [37,39]. Two *G. galloti* isotopically resembled *G. goliath* at the Golf Cave; the other two individuals were more similar to rabbits (Figures 3 and 6). Somewhat unexpectedly, the introduced ferret (*Mustela furo*) from the Buenavista region did not have a particularly elevated $\delta^{15}N$ value (although it did plot within the space expected for a coastal scrub faunivore; Figure 5). We suspect that this individual preyed on rabbits [85–87]. It is also possible that this individual escaped from captivity or that it migrated from a site further inland. Home ranges for feral *M. furo* on New Zealand are 135 to 163 hectares [110]. Thus, it would not be particularly challenging for an individual to traverse the ca. 2 to 3 km between thermophilous forest and the Buenavista del Norte coastline.

Fig. 2.9. *Beginning of Discussion showing how the authors summarize the main points and then move on the interpret data. Source: Crowley et al. 2019. (CC: BY 4.0)*

6.2 Conclusion

The Discussion usually serves as the conclusion. If there is a separate conclusion section then it should be brief, only one or two paragraphs. In the conclusion typically authors offer either recommendations or future perspectives for the research. Figs.

2.9 and 2.10 show the Discussion and Conclusion sections from the sample paper.

previous authors, the radiocarbon record does not preclude the possibility that humans overlapped temporally with the now-extinct species. Confidence intervals for radiocarbon dated *C. bravoi* (Table 2) suggest that it is highly likely this species was still present on the island when humans first settled Tenerife. They also demonstrate that we still have very little confidence in when either species actually disappeared. Only three *G. goliath* have been radiocarbon dated. Further investigation into the timing of extinctions on the island is clearly warranted (Table 2).

5. Conclusions

Here we have re-evaluated the foraging ecology of the recently extinct *Gallotia goliath* and *Canariomys bravoi* in northwestern Tenerife using carbon and nitrogen stable isotopes. We found substantial evidence for trophic omnivory in both species. Relatively elevated $\delta^{13}C$ values for *C. bravoi* from the inland Icod municipality also suggest that *C. bravoi* may have regularly foraged in the forest canopy. Slight differences in carbon and nitrogen isotope data further suggest that the two extinct species likely partitioned their resources when living in sympatry. They also indicate that the extant *Gallotia galloti*, as well as introduced rats and rabbits, may consume resources that are similar to those consumed by *G. goliath* in coastal habitat. These findings are consistent with morphometric and dental microwear data, which suggest that (1) both species consumed a variety of vegetal and animal foods, and (2) *C. bravoi* spent time in the trees [26,27,30,40]. New radiocarbon dates extend our understanding of the paleoecology of *C. bravoi* during the late Pleistocene but do not help narrow the timing of when either species disappeared from Tenerife. With continued lack of evidence for another driver, we echo the conclusions of Rando et al. [23] that the initial wave of human settlers drove the extinctions of the now-extinct species. Further research on the island will almost certainly refine our understanding of the paleoecology and extinction triggers for both species, and especially lizards.

***Fig. 2.10**. End of Discussion and the Conclusion. The Discussion calls for further research while the Conclusion summaries the overall paper. Source: Crowley et al. 2019. (CC: BY 4.0.)*

7 Back Matter and References

Back matter refers to everything that comes after the main text of the document. (See Fig. 2.11 for an example.)

7.1 Addendum, Acknowledgments, etc.

At the end of the document but before the end reference list there may be several items included. For example you could include a list of supplementary materials, either unpublished or available online. Acknowledgments usually identify funding and the contributions of those who are not listed as authors. It has also become common to include an author statement that credits the role of each author such as who participated in research, writing, revising, etc.

7.2 References

Citing or documenting your sources are crucial both to avoid plagiarism and for credibility. The Crowley et al. (2019) document that has been used as a sample for you to look over only has 18 pages of text but 120 references!

You probably learned Modern Language Association (MLA) citation style either in high school or your first English class at college. This style, however, is not used in the sciences. You also may have learned APA style citations. This refers to the to the American Psychological Association's style guide. APA is used in the social sciences and in some other disciplines. In the physical and natural sciences many of the journals will use what is called Scientific Style and Format from the book of the same name prepared by the Council of Science Editors (CSE). If you learned APA (or what is commonly called the author-date) citation system then you are in luck as this style is similar to the CSE name-year citation system. Many science journals, however, use the alternate CSE style known as citation-

sequence. You should become familiar with both the name-year and citation-sequence systems but place special emphasis on learning whichever system your major uses.

For example, biology typically uses CSE name-year system, physics uses the CSE citation-sequence system, but chemistry uses the American Chemical Society (ACS) system (which is very similar to CSE citation-sequence system.) Thus it is important to learn what is the commonly accepted way of citing references in your major.

Once you have discovered the citation system your major uses, the next step is to learn how to do both in-text references and end references. In-text references occur in the text where the information is written and usually only contain just enough information to redirect the reader to the end references. The end references contain all the information a reader needs to find the source of the information. See the chapter on "Citation & Copyright" for more information. Please consult *Scientific Style and Format* or the style guide for your career field for a more detailed overview of references.

Writing tip: When writing in the sciences using quotations is generally discouraged. Instead it is expected that one will summarize or synthesize the findings or main points and then cite the source.

7.3 Appendixes

After the references if necessary one can include appendixes (sometimes spelled appendices). They should be numbered with an Arabic numeral and have a title. Appendixes could include supplementary materials such as calculations, figures, or tables that are too long to fit in the Results or other sections without interrupting the flow of the text, glossary of terms, or sample documents.

either species disappeared from Tenerife. With continued lack of evidence for another driver, we echo the conclusions of Rando et al. [23] that the initial wave of human settlers drove the extinctions of the now-extinct species. Further research on the island will almost certainly refine our understanding of the paleoecology and extinction triggers for both species, and especially lizards.

Supplementary Materials: The following are available online at http://www.mdpi.com/2571-550X/2/1/10/s1, Table S1: Stable isotope and radiocarbon data for individual specimens included in this study, Table S2: Published data for foliage from modern C_3 plants and expected $\delta^{13}C$ and $\delta^{15}N$ values for herbivores and faunivores that consume C_3 plants in each biome, Table S3: 95% and 50% confidence interval estimates for last occurrences for *Canariomys bravoi* and *Gallotia goliath*.

Author Contributions: Conceptualization, B.E.C. and Y.Y.; Methodology, B.E.C.; Formal Analysis, B.E.C. and J.C.R.; Resources, S.G.M., J.C.R., and Y.Y.; Writing – Original Draft Preparation, B.E.C.; Writing – Review and Editing, B.E.C., S.G.M., J.C.R., and Y.Y.; Visualization, B.E.C.; Funding Acquisition, B.E.C.

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Conflicts of Interest: The authors declare no conflict of interest.

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Fig. 2.11. *Showing the end of the Conclusion and Back Matter including the beginning of the References list. Source: Crowley et al. 2019. (CC: BY 4.0.)*

8 Writing a Literature Review

The literature review is a common genre in the sciences. You will encounter it in your readings and you will probably be required to write one in your science classes. Certainly if you go on to major in the sciences you will need to be able to write this common type of document. Part of doing science is background research and the literature review demonstrates that you have done that. Literature reviews often are found in the introduction of a larger document, such as a research paper, but also can function as a stand-alone document.

The literature review is not an annotated bibliography. The annotated bibliography simply asks you to summarize each source you read. The literature review goes beyond the annotated bibliography—you should critically analyze each source you read and put the authors into conversation with each other—synthesize the information. The key to your literature review is to organize it around themes, trends, topics, or methods. A good literature review 1) sets up the context: where do each of the articles fit within the broader scholarly conversation; 2) shows your credibility: you are familiar with important ideas and even debates on this topic; 3) and if it is part of a research article: shows what gaps are there in the research that your document will address (Global Communications Center).

If your literature review is not part of a larger document then it should be structured as follows:

- Title page with author and date
- Abstract (optional, check with your instructor)
- Introduction (what is overall topic and your purpose to this

document?)
- Body
- Conclusion (summarize main ideas, put in context of larger area of study such as discipline, etc.)

Writing tip: you might ask yourself, "What would the author of article A say to the author of article B about the same subject? Does author A add to author B's research? Does author A critique author B's research?"

Here are some do's and don'ts from the Global Communications Center handout.

Do:

- Describe overall theme
- Connect multiple studies
- Situate individual authors within a trend
- Summarize research ideas and show which ones are the most important
- Show limitations of previous research or weakness in methods

Don't:

- Summarize only one text
- Give too many details on one single author
- Fail to connect to overall theme
- Simply present a lot of data without explanation

9 Final Thoughts

Many students are surprised to find how much reading and writing they do in the sciences. In a 2015 survey conducted of transfer students at the University of Utah, when asked how many were surprised at how much reading was assigned around 7% were very surprised, 16% were fairly surprised, 35% were somewhat surprised, about 33% were not very surprised, with only a 9% not at all surprised (Toth 2015). That means of the 275 students surveyed, more than half of the students were surprised to some level at the amount of reading. For writing the survey results were a bit better with only about 35% of the students expressing some level of surprise at the amount of writing (Toth 2015). But reading and writing does not end with school. As stated in the beginning of this document one of the most important part of being a scientist is sharing one's research.

As you move forward in pursuing your education and on into your career in the sciences there are some sources that may proves useful. There are several writing centers that keep resources online such as the Global Communication Center at Carnegie Mellon University or the Online Writing Center at Purdue University. At some point as your writing becomes more complex you may need to purchase the style guide for your specific field whether it be the CSE style guide or another one. Of course the best resource will always be your instructor.

10 Acknowledgements

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Tips For Writing Tutors

When faced with a text written by a student for a science course how should you approach the text? What help should you offer the student for improving their text? What should you prioritize?

1. **Documenting sources**. The most important concept for students to learn in writing in the sciences is the need to document sources. This is important to demonstrate that 1) students clearly separate what are their own ideas and what are ideas taken from elsewhere and 2) that they have situated their ideas in the larger context of research. Quotations in student's work are acceptable but are rare in the sciences. It is ideal instead for students to work towards learning to paraphrase or summarize their sources. Generally published science papers do not have quotations. Make sure students have documented their sources both in the text and in the bibliography. In terms of documenting sources APA is generally accepted although an instructor may require something different.

    - Often students do not document the source of figures, pictures, graphs, tables, and charts that are not their own so please pay attention to these. Worse, students often cut and paste copyrighted material from the internet. Please explain that they cannot use copyrighted materials without

written permission from author/creator (for pictures, etc.). You may wish to guide them to copyright free or other license types that they can use. For more about fair use see Chapter II Copyright and Fair (Educational) Use in this textbook.

2. **Formatting**. Students struggle with the scientific format (IMRaD) so having a basic understanding of this format is important to help them. Students also struggle with many of the basics of formatting such as where to put a figure number or how to caption a figure or a table. This information can be reviewed under Section 5 Writing the Results Section.
3. **Writing Style:**

    - Writing in the sciences is characterized by concision. Concision refers to eliminating unnecessary words without omitting important information.
    - Although active voice in general is preferred, passive voice will occur when emphasizing the research process, experimentation, etc. such as is found in the materials and methods section of a report (CSE 2014, 116).
    - Typically the writing is to be objective or bias-free. This does include avoiding the use of "I" although some instructors will allow it.
    - Students often are not aware that they cannot use people's first name or given name when referencing a person in a text. Generally use of surname is preferred

for all situations in formal writing.

Finally *Scientific Style and Format* (CSE 2014, 8th edition) can be referenced, if needed, for other questions such as special scientific conventions. This manual is based on the *Chicago Manual of Style*.

> Remember that the student's instructors are the content experts. You as a tutor do not need to be familiar with the content in order to help them have better writing.

PART III

INTRODUCTION TO WRITING IN ENGINEERING

Prepared for the ENGL 2100 Technical Writing course at Salt Lake Community College by Daniel D. Baird (faculty in the English, Linguistics, and Writing Studies Department) and Korin Holden (adjunct faculty in the Engineering Department). Reviewed by Aimee Birdsall (faculty in Engineering Department).

Overview

This chapter will introduce you to some basics of writing in engineering. Many journal articles for engineering use what is called the scientific format. This chapter does not intend to cover in detail the differences between writing in the sciences and engineering but instead point out some specifics that are unique to engineering writing as opposed to scientific writing when using the scientific format.

> It is assumed that you are already familiar with the scientific format, also known as IMRaD (Introduction, Methods, Results, and Discussion). If not you can review the chapter, "Introduction to Writing in the Sciences" in this textbook.

Throughout this chapter we have used a published engineering paper for examples of the ideas you are learning. The language of the paper may seem difficult, but pay attention to the concepts pointed out in each example so that you can learn to recognize and eventually learn how to use these concepts in your own writing.

Please use this chapter to learn both how to read engineering articles and how to format and write your own papers in your engineering classes.

Finally, this document is meant to be an introduction only. Your instructor's or a publisher's requirements always supersede what is written in this textbook.

Writing an Abstract and Introduction

Abstract

The goal of an engineering abstract is to efficiently and concisely express the purpose and results of your paper. Readers look at the abstract because they are in search of answers, and the abstract allows them to know if your paper is of use to them or not. If the research problem is presented but not the results that address the problem, the reader will not read the article and will search elsewhere. By including the overall results in the abstract, the reader gets a feel for the article and if it is worth reading.

> At least in engineering, one may read the abstract for free. If the abstract demonstrates that the article is what the reader is searching for, the reader can buy the article for a fee. For this reason, the abstract needs to be a faithful representation of the article. Nobody wants to waste money on something that is misrepresented.

Abstract follows a structure of introductory sentence, a methods sentence, 2-3 sentences of key data points and a conclusion sentence on the overall result. First, there should be an introductory sentence on the research that is needed in a specific area or a problem that needs to be examined. It should introduce the study; that is, the plan to address the problem.

Next, the abstract should also include a sentence on data such as tests, samplings, survey results, etc. Following the method of study, a two to three sentence discussion that includes key data points of the study would be helpful to the reader. The abstract should not include mathematics or citations (remember–it is a summary, not a detailed explanation). The conclusion of the abstract should share the overall results from the study. An abstract should stand on its own, i.e. the reader should be able to understand the content of the paper just from reading the abstract.

For an example of how to write an abstract, see the sample document below (Fig. 3.1). Notice the length and placement of the abstract. Also notice that at the end of the abstract are a list of keywords that would be used in a search engine to find the article.

Journal of Civil & Environmental Engineering

Loghmani et al., J Civil Environ Eng 2019, 9:2

Research Article Open Access

Evaluation of Indoor Air Pollution in Urban Homes: A Case Study from Isfahan, Iran

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Abstract

Burning fossil fuels has a significant effect on indoor air quality. In this study, the concentration of SO_2, NO_2, NO_x, NO, CO was measured in five houses at Isfahan focusing attention on kitchens as a source of indoor pollutants. Selected houses differed in terms of kitchen type and finish, presence or absence of a range hood, and type of stove heating. Samplings were done over three days at a fixed time window for each location. Results showed that in closed kitchens without a range hood, the 1-h concentration of pollutants was higher compared to kitchens having open and semi-open range hoods. Minimum pollutant levels were seen for kitchens using an electric stove with a range hood.

Keywords: Indoor air pollution; Kitchens; Gas stove; Hood range

Introduction

Since the dawn of humanity, humans have always had a constant struggle about indoor air pollution. Due to its importance, scientists have tried to evaluate the effects of air pollutants on human's health and diminish their harmful risks in the best way possible. The World Health Organization (WHO) has reported that indoor air pollution is one of the most significant environmental factors that threaten human's health [1]. Generally, Indoor Air Pollution (IAP) is defined as air quality within and around the structures of buildings which leads to discomfort and/or health problems for the occupants or residents [2]. Carbon Monoxide (CO), Particulate Matter (PM), Nitrogen Dioxide (NO_2), formaldehyde, black carbon, Polycyclic Aromatic Hydrocarbon (PAH) are just a few of the more common indoor pollutants that are generated by incomplete burning of fuels for heating purposes like cooking [3-6]. Pratali et al. [7] stated that during cooking, fumes will be generated from fuel burning, oil heating and food processing at high temperature. The generated particulate matter cloud indexed by $PM_{2.5}$ contains organic compounds and hazardous chemicals, like metals, polycyclic aromatic hydrocarbons, carbonyl compositions, benzene and quinines.

Epidemiological estimates show that about 4.5 million deaths caused by indoor air pollution including pneumonia, stroke, Ischemic Heart Diseases (IHD), Chronic Obstructive Pulmonary Diseases (COPD), and Lung Cancer (LC). White et al. [8] showed that exposure to air pollution including PM, NO_2, and NO_x enhances the incidence of breast cancer. In other study, Ritz et al. [9] showed that exposure to air pollution can increase the risk of Parkinson's disease. In two studies about the effect of air pollution on human's health, it was concluded that NO_2, $PM_{2.5}$, and O_3 increase the non-accidental mortality rate in a large population of Canadians [10]. The main concern about indoor air pollution is that individuals like women, children and older adults spend such a large proportion of time inside the home, estimated at up to 90% [11,12]. In a study Singh [13], indicated that more than half of women cooking with traditional cooking stoves experience health problems.

In order to reduce this healthcare burden, National Health Policy tries to reduce environmental hazards through practical control measures for decreasing air pollution. But, to better address this, more research should be conducted into fundamental concepts and descriptions of air pollution, their sources, and negative effects on human health in a localized context. This is because indoor air quality usually varies between different locations depending on human activities, use of consumer products and household installations, building materials, infiltration of outdoor air sources and overall ventilation [14].

Iran is considered a place that has abundant gas resources. Therefore, natural gas is widely used for heating houses. According to the report from the NIGC (National Iranian Gas Company), in 2005, 11.6 million families are covered by the gas distribution network [15]. Burning natural gas for heating the indoor room volumes and water is the main reason that increasing pollutant concentrations may develop in the home environment, particularly, during cold seasons. The aim of the present study is to measure the concentration of gaseous pollutants such as NO_2, SO_2, CO, NO NO_x in kitchens of houses having different structural building features and kitchen types and the potential correlation between these features in different parts of Esfahan province, to assess exposure to indoor air pollution.

Materials and Methods

Description of study area

Isfahan has an arid climate with low average rainfall and is in the center of Iran. Sample locations are shown in Figure 1 where the five homes were selected. These buildings varied in area (m^2), year built, single or double story, and flooring type as described in Table 1. Regarding the buildings, each had the same number of bedrooms and all were naturally ventilated from standard windows. All windows and other ways for outdoor air penetration were blocked during sampling. To calculate realistic levels of pollutants, monitoring was done without any control or interference with the normal activities of the residents. From Table 2, three homes had an open kitchen and two others had an enclosed kitchen. Open kitchens were integrated with the living room and connected to other rooms in the home through interior doorways. Cooking appliances had several differences in term of stove type and range hood. In three homes, venting range hoods used in the kitchens were installed above the cooktops.

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Fig. 3.1. *This shows the beginning of the article including the abstract, introduction, and beginning of the methods section. Source: Loghmani et al. 2019. (Open Access Journal.)*

Introduction

The introduction could be very lengthy or quite short depending on how long and involved the research is. At times, an introduction could include an abbreviated literature review or history of the project. If the research is a part of a bigger endeavor, the entire study could be briefly discussed and referenced.

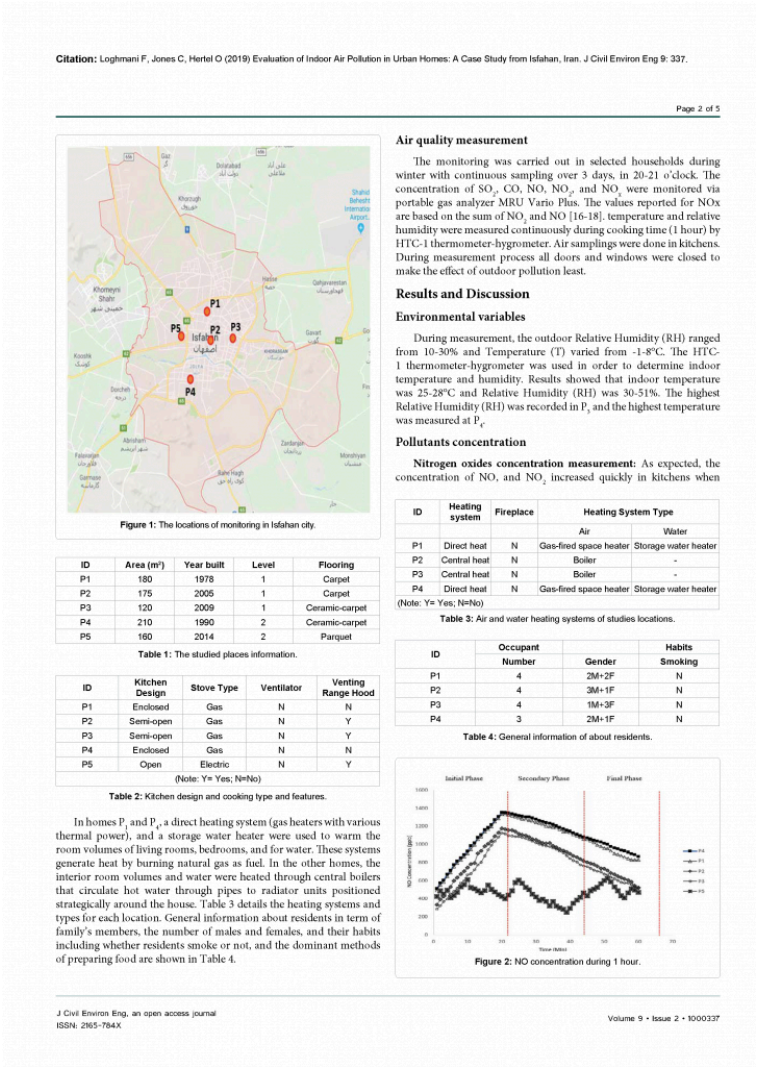
Writing the Methods Section

The Methods section (also called Materials and Methods) allows the reader to see how the study was carried out (Fig. 3.1 and Fig. 3.2). This section can be enlightening because it connects the dots from the introduction (telling the reader what the problem is) and the results (showing data on "solutions" to the problem). There is more than one way to go about solving a problem. By explaining the approach used, the reader time is able to understand how the research progressed from step to step.

The results are a product of the methods used, so they should be carefully analyzed before beginning your testing. Questions to consider might be: Could it be done a different way that would be easier, more feasible, take less time and yield "better" results? Did the method follow all necessary steps? Did it use the scientific method? Was it ethical?

The methods section can also describe the technical theory involved in the study. If the research called for special equipment or software, it could be mentioned in the section.

Finally, stating the method and how the study was carried out in turn allows others to repeat the study, thus lending credibility to your article by showing that the results can be reproduced using the methods described. Different branches of engineering have specific testing procedures that make studies easy to duplicate by listing which procedure and standard you used in your methodology. An example of these standards would be those set by the American Society for Testing and Materials (ASTM).



Citation: Loghmani F, Jones C, Hertel O (2019) Evaluation of Indoor Air Pollution in Urban Homes: A Case Study from Isfahan, Iran. J Civil Environ Eng 9: 337.

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Figure 1: The locations of monitoring in Isfahan city.

ID	Area (m²)	Year built	Level	Flooring
P1	180	1978	1	Carpet
P2	175	2005	1	Carpet
P3	120	2009	1	Ceramic-carpet
P4	210	1990	2	Ceramic-carpet
P5	160	2014	2	Parquet

Table 1: The studied places information.

ID	Kitchen Design	Stove Type	Ventilator	Venting Range Hood
P1	Enclosed	Gas	N	N
P2	Semi-open	Gas	N	Y
P3	Semi-open	Gas	N	Y
P4	Enclosed	Gas	N	N
P5	Open	Electric	N	Y
(Note: Y= Yes; N=No)				

Table 2: Kitchen design and cooking type and features.

In homes P_1 and P_4, a direct heating system (gas heaters with various thermal power), and a storage water heater were used to warm the room volumes of living rooms, bedrooms, and for water. These systems generate heat by burning natural gas as fuel. In the other homes, the interior room volumes and water were heated through central boilers that circulate hot water through pipes to radiator units positioned strategically around the house. Table 3 details the heating systems and types for each location. General information about residents in term of family's members, the number of males and females, and their habits including whether residents smoke or not, and the dominant methods of preparing food are shown in Table 4.

Air quality measurement

The monitoring was carried out in selected households during winter with continuous sampling over 3 days, in 20-21 o'clock. The concentration of SO_2, CO, NO, NO_2, and NO_x were monitored via portable gas analyzer MRU Vario Plus. The values reported for NOx are based on the sum of NO_2 and NO [16-18]. temperature and relative humidity were measured continuously during cooking time (1 hour) by HTC-1 thermometer-hygrometer. Air samplings were done in kitchens. During measurement process all doors and windows were closed to make the effect of outdoor pollution least.

Results and Discussion

Environmental variables

During measurement, the outdoor Relative Humidity (RH) ranged from 10-30% and Temperature (T) varied from -1-8°C. The HTC-1 thermometer-hygrometer was used in order to determine indoor temperature and humidity. Results showed that indoor temperature was 25-28°C and Relative Humidity (RH) was 30-51%. The highest Relative Humidity (RH) was recorded in P_3 and the highest temperature was measured at P_x.

Pollutants concentration

Nitrogen oxides concentration measurement: As expected, the concentration of NO, and NO_2 increased quickly in kitchens when

ID	Heating system	Fireplace	Heating System Type	
			Air	Water
P1	Direct heat	N	Gas-fired space heater	Storage water heater
P2	Central heat	N	Boiler	-
P3	Central heat	N	Boiler	-
P4	Direct heat	N	Gas-fired space heater	Storage water heater
(Note: Y= Yes; N=No)				

Table 3: Air and water heating systems of studies locations.

ID	Occupant Number		Habits Smoking
		Gender	
P1	4	2M+2F	N
P2	4	3M+1F	N
P3	4	1M+3F	N
P4	3	2M+1F	N

Table 4: General information of about residents.

Figure 2: NO concentration during 1 hour.

Fig. 3.2. *Materials and Methods continued from Fig. 3.1. Also first part of Results and Discussion. Source: Loghmani et al. 2019. (Open Access Journal.)*

In Figure 3.2 observe how figures and tables are used to

present data for the materials and methods section. Each figure or table is referred to and explained in the text.

Writing the Results and Discussion Section

Results

The Results section is where you insert the data (Fig. 3.3). One of the important way to convey results is through charts. The data in the charts needs to be meaningful. You do this by formatting charts with appropriate axis labels, legends and units. The title or caption of the chart or figure must capture the meaning of the data. Choose the data carefully and make it count–it is a communication of the entire paper. Charts, graphs, tables, and plots are called "descriptive data," meaning they need to do the bulk of describing the data for you. Make sure they are well labeled!

Writing Tip: The chart or figure should communicate the ideas of the paper as a whole so that a reader could discern what 90% of the paper is about just by looking at the visual aids.

As the researcher and author, it is important to be ethical and not skew the data (meaning not to distort the data to how you would like it). Most data is not perfect but it is still important to show the imperfections. Data needs to be inclusive and unbiased.

Writing Tip: Don't forget to create a caption for the figure or table. Also don't forget to cite your source for any referenced information. The title for a figure goes below, the title for a table above, and the caption for a figure or table appears below the information (see Fig. 3.3). It is easy to accidentally get this wrong.

Data could be placed in the back of your paper as an appendix, but most data is referenced in the text and it is nice to see the sentence and its corresponding chart side by side.

cooktops were working with the highest flame, continuously. Hence, there is a direct relationship between burning natural gas through gas stoves and the concentration of NO_2 at home environment [19]. After finishing cooking events, concentrations started to decline, gradually, in P_1 and P_4 through air exchange with other parts of homes and after a period remained constant because gas fired space heaters fired regularly in bedrooms and the living room. Figure 2 represents NO concentration during cooking for each of the five locations.

Mainly, the process of cooking in the different homes studied places followed three main phases. During the initial phase of cooking, the food material becomes semi-cooked. Here, stoves burn the most amount of natural gas in order to create maximum heat. The greatest concentration of pollutants is produced during this phase. In the secondary phase, the process of cooking becomes relatively complete. Compared with the previous phase, the least amount of natural gas is burnt because this phase occurs gradually. The final maintenance phase is where the prepared foods are kept warm. In this phase, minimum heat is generated by stoves. Here, the lowest amount of fuel is consumed and similarly, the lowest concentration of generated pollutants is produced. From the graph, the concentration of NO raised in first 20 min (Initial phases) and eventually reach to highest point. In next two phases, NO concentration declined gradually which was related to reduction of consumed natural gas.

Measurements in the P_2, P_3 where kitchens were open and semi-open indicated that concentrations reduced with rapid pace because of higher air exchange with other sections of home and using range hood. These days, many studies have referred to the importance of range hood on the concentration of pollutants. Hänninen et al. [20] investigated the infiltration level and fine particle concentration of housing and found that the ventilation rates by infiltration were proportional to the indoor $PM_{2.5}$ generated non-environmental tobacco smoke concentration. Gens et al. [21] stated that improvements made to the air tightness of buildings without enough air exchange rate can have unintended adverse health effects.

Also, these houses enjoyed central heating system where the boiler is located outside occupant's environment. In this regard, the boiler had little influence on the indoor concentrations of NO, NO_2. Another important point in these locations is that NO_2 concentrations in P_3 were lower than P_2 which might relate to the its higher relative humidity content. Francisco et al. [22] stated it is more likely that the wide range of NO_2 decay rates is due to the amount of water mists in the air. However, this explanation is not supported completely.

P_5 showed a different pattern as compared to other homes because of the use of an electric stove. The amount of emitted NO and NO_2 were not surprisingly lower than the other indoor environments. Although studies have reported higher concentrations of nitrogen compounds in homes with natural gas cooking burners compared to homes with electric cooking [23], in this location, a fireplace which was burning natural gas, plays such a prominent role in emission of pollutants like NO_2 and NO. During cooking time, the concentration of both NO_2 and NO remained constant. Such pollutants were generated by the fireplace and some particles which traveled from living room to the kitchen, were driven out via range hood and thermally diffusive flow from their source.

Figure 3 shows the highest 1-hour concentrations of NO_2. The NO_2 level in all house types were higher than the 100-ppb threshold assigned by the EPA. Almost all the homes had NO_2 levels exceeding 50-ppb. Hence, it is concluded that unexpected emissions might occur in homes where natural gas stoves are used. Additionally, the average NO_2 concentration in cooking time is calculated by the sum of the concentration of NO and NO_2 and represented in Figure 4.

Concentration measurement: Emitted CO in the home environment is associated with residential appliances, and type of fuels used for cooking, and heating purposes [24-26]. A large proportion of people in developed countries use electric stoves, however, in developing countries particularly like Iran that enjoy plentiful oil and gas resources, gas stoves are preferred. Increasingly, research is focused on measuring indoor CO concentration [27] monitored indoor CO concentrations over a 1-hour interval at different homes. The results varied between 6-8 mg/m^3. Figure 4 represents the average 1-hour concentration of CO during cooking process. These results measurements indicated that CO concentrations were lower than WHO standard which are set at 30.55 ppm for 1-h [1]. Based on Figure 5 the highest concentration of 1-hour CO were measured at P_1 and P_4 in kitchens not having a range hood and enclosed type of kitchen and more importantly continuous use of gas heaters.

However, CO had an unpredictably lower concentration in P_5. One of the most significant justifications was related to method of cooking. Generally, two methods of cooking including frying and boiling are common among Iranian families. At P_3, boiling is preferred to prepare food ingredients. In contrast, in P_1 and P_4 both boiling and frying are used, and at P_2, frying is more common. Depend on fuel type, cooking methods and ingredients which are used in kitchens, the type and amount of air pollutants generated by cooking can be varied [28-30]. Huboyo [31] reported that cooking type can play a crucial role in generated CO. During boiling of water, the CO concentration was at lowest point because water particles can absorb emitted CO. Lee [32] found that the most amount of pollutants are generated during barbecuing. Jiang [33] stated that water mists can diminish both CO and CO_2 concentrations during cooking.

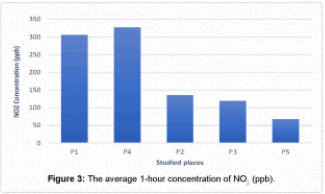

Figure 3: The average 1-hour concentration of NO_2 (ppb).

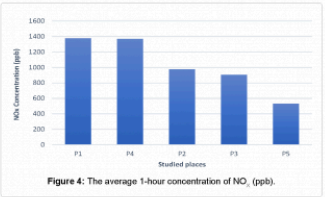

Figure 4: The average 1-hour concentration of NO_2 (ppb).

***Fig. 3.3**. Continuation of Results and Discussion from Fig. 3.2. Source: Loghmani et al. 2019. (Open Access Journal.)*

Discussion

The Discussion section is the place to explain the results section. If the research went as planned, there is no need for an in-depth discussion–results and discussion can be covered side-by-side in the same section as in the sample paper used for this chapter (Fig. 3.2, Fig. 3.3). Notice that both the presentation of data in charts and the discussion of data in the combined Results and Discussion are represented in Figure 3.3.

On the other hand, if the methods or the data do need to be explained, a separate discussion section provides a place to explain the study: what worked and what didn't. Here you may choose to talk about the outliers in the data, why there is some "noise," or what had to be adjusted after the research began.

Writing Conclusions

The Conclusion section gives a good wrap-up of the paper (Fig. 3.4) and answers the question "What was discovered while doing the research?" This section could touch on how the study was set up, if it went as planned, and whether the data support the outcomes of the study.

The conclusion could also share the overall result of the study. If it was groundbreaking, the conclusion could include a plan for future research exploring an offshoot of the current study or new research in a different direction all together. Lastly, suggestions could be made to implement the findings of the study into practice. A plan of implementation could be included, but is not a requirement.

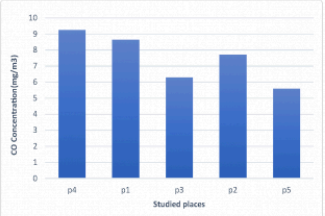

Figure 5: The highest 1-hour concentration of CO (mg/m^3).

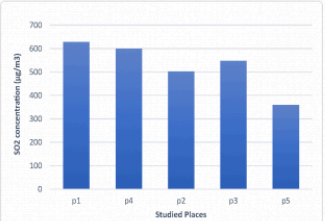

Figure 6: 1-hour average SO_2 concentration (µg/m^3).

According to the EPA, standard levels in houses without using gas stoves are 0.5-5 ppm, and with gas stoves are 5-15 ppm (EPA 2009). Lee [32] found that cooking methods in restaurants had various emissions of particles and CO. The highest levels of pollutants are generated during barbecuing. Zhao [11] state that the cooking method can have a significant impact on emissions from Chinese cooking. Oil-based cooking produces air pollutants at much higher levels than water-based cooking. CO in P_3 mainly generated by fireplace and then because of air exchange spread out in kitchen.

Concentration of SO_2: The average concentrations of SO_2 in kitchens are presented in Figure 6 Like the other kinds of pollutants; generated SO_2 heavily depends of the type of cooking appliances and fuels [34]. Obviously, the concentration of SO_2 in P_1 and P_4 kitchens were relatively higher than others. The lowest concentration of SO_2 was recorded at P_2. Generally, four locations had SO_2 concentration near the national standard of AIQ (0.50 mg/m^3, 1 h-avarage), and one location had a lower SO_2 concentration. In similar investigation, Cichowicz studied the concentration of NO_2, NO_x, O_3, SO_2, CO, PM_{10}, $PM_{2.5}$, and C_6H_6 in selected city, town and rural sites. [35].

Conclusion

This work was conducted under ordinary living conditions and without any control over the occupant's normal daily activities. Smoking did not take place by any occupants and all sampling was performed during winter. Selected pollutants were measured using continuous monitoring and allowed us to calculate the concentration of SO_2, NO, NO_2 and CO. Our results support the expectation that the concentration of indoor air pollutants grows dramatically during cold seasons because of the extra requirements for heating. They found out that the highest concentration of these pollutant occurred in winter. Importantly, in traditional kitchens (enclosed and semi-open), pollutants had a higher concentration. Therefore, residents particularly housewives, could be more affected by indoor pollution in such kitchens. Stove and fuel type, ventilation, method of cooking, heating system, and human activities, are other factors which play a crucial role in the concentration of indoor pollutants within enclosed spaces. To minimize the negative effects of indoor pollution and control them, it is suggested that efforts should be made to provide incentives and opportunities for using clean energies like electric instead of fossil fuels.

Acknowledgement

I am using this opportunity to express my gratitude to everyone who supported us throughout the course of this study. We are thankful for their aspiring guidance, invaluably constructive criticism and friendly advice during the project work. We are sincerely grateful to them for sharing their truthful and illuminating views on several issues related to the study. I express my warm thanks to Dr. Seena Rejal and Dr. Mohammad Ali Rejal for their financial support and scientific guidance.

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Fig. 3.4. *The Conclusion of the article and the beginning of the References section. Source: Loghmani et al. 2019. (Open Access Journal.)*

Importance of Citations

In this world where cats seemingly play the piano on the internet, one has to ask what is actually fact. Just because someone posted something doesn't mean there is any substance to it. Citations are crucial for the credibility of a paper.

As the author, one should be researching reputable papers to find factual information. Good information can be found on websites, but the best information usually comes from journals that contain similar research and have published the results.

Readers are more likely to view the paper as a trusted source if there is a list of citations that are well documented and, even better, from journal sources backed by national societies that are respected. People want to see facts.

> The sample journal article used in this chapter employs citation-sequence (also called numbered) citations (see Fig. 3.5). This chapter on writing in engineering uses the author-date system. Both are used in engineering journals; it is up to you to be aware of which citation style is used by the journal or publisher you are submitting to. If you are writing your paper for a class, ask your instructor.

Citation: Loghmani F, Jones C, Hertel O (2019) Evaluation of Indoor Air Pollution in Urban Homes: A Case Study from Isfahan, Iran. J Civil Environ Eng 9: 337.

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Fig 3.5. *List of references in numbered or citation-sequence system. Source: Loghmani et al. 2019. (Open Access Journal.)*

Differences Based on Type of Engineering

This chapter has focused on writing in the scientific format. The ideas in this chapter are meant to give you a brief introduction only. Be aware, however, that chemical, civil, computer, electrical, mechanical engineering, and computer science each have their own journals, websites, organizations, etc. They also have their own requirements when it comes to writing. As you progress in your major you will encounter more individualized and varied styles than discussed in this chapter.

Each of the websites below includes guides and templates for authors wishing to write in these fields. You may wish to consult these websites and their resources as you go forward in your schooling:

- American Institute of Chemical Engineers (AIChE)
- American Society of Civil Engineers (ASCE)
- The Institute of Electrical and Electronic Engineers (IEEE) for electrical engineering and computer science (and computer engineering)
- American Society of Mechanical Engineers (ASME)

For a more in-depth discussion of writing and engineering see the Fundamentals of Engineering Technical Communications textbook by Ohio State University.

> Writing tip: For the specific format of your paper please follow your instructor's guidelines.

References

Loghmani F, Jones C, Hertel O (2019) Evaluation of indoor air pollution in urban homes: A case study from Isfahan, Iran. Journal of Civil & Environmental Engineering 9: 337. An Open Access journal. Accessed March, 2020.URL: https://www.hilarispublisher.com/open-access/evaluation-of-indoor-air-pollution-in-urban-homes-a-case-study-from-isfahan-iran.pdf

Tips for Writing Tutors

The STEM fields including engineering require concise, well organized, and direct writing. Unlike English writing that depends on narrative writing and quotations for support, engineering writing focuses on documenting sources and presenting data in tables, graphs, etc. When working with engineering students here are some things to check for (in order of importance):

- Citations are correctly used and formatted and that information is summarized rather than quoted
- Figures (graphs, charts, etc) and tables are meaningful, have captions, and are labeled
- Abstract follows a structure of introductory sentence, a methods sentence, 2-3 sentences of key data points and a conclusion sentence on the overall result
- The results section includes a table or chart and the discussion section is meaningful and correlates with results

PART IV

INTRODUCTION TO WRITING IN COMPUTER SCIENCE

Prepared for the ENGL 2100 Technical Writing Course at Salt Lake Community College (SLCC) by John Gordon, Assistant Professor, Computer Science & Information Systems (CSIS) Department.

Overview

This chapter introduces you to writing in Computer Science (CS). CS is a broad field with numerous distinct pathways through education and the Information Technology (IT) job market. A person interested in the IT field can choose to specialize in areas such as Software Development, Database Administration, Network Administration, Data Science, Cybersecurity, and others. Each specialization within IT has its own educational and skill expectations. Writing across the disciplines involves some differences in approach; however, professionals in IT generally follow the Institute of Electrical and Electronics Engineers (IEEE).

Writing in CS and in the IT field is often assumed to fall into the purview of Technical Writing primarily: that is, system documentation, specifications, instructions, and the like. However, IT professionals can also expect to write in other ways in their careers. Although the focus of a technical professional is on the tasks of their job, they also must communicate in writing in various ways, such as business and professional writing, project management communications, interpersonal communications via email and online platforms, and employment-related writing. To keep the scope of this chapter manageable, we will focus on a few key types of writing expected in the IT industry.

The Writing Landscape in Computer Science

Many general education courses required by the CS major involve writing in college. Writing in various forms is a critical component of many required courses within the major. In addition, there is increasing support by many in the field of Writing Studies that programming itself is a form of writing and coding literacy.[1] CS programs at most colleges, including SLCC, offer a course in Software Engineering. A significant component of that course focuses on activities in the IT industry, such as gathering project requirements, proposing solutions to the problem, and project management. All of these activities involve writing.

Most CS professionals work in IT Departments among teams of other IT professionals. An IT department in a mid-to-large-sized company might look something like this:

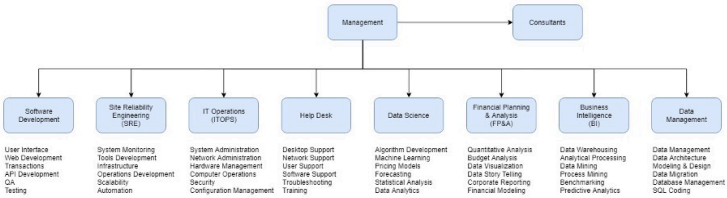


Figure 4.1: Example Structure of an IT Department, John Gordon, Salt Lake Community College.

1. Vee, Annette. Coding Literacy: How Computer Programming is Changing Writing. The MIT Press, 2017.

In Figure 4.1, the Management group would include senior IT personnel, such as the Chief Information Officer (CIO) and other senior managers who oversee broad areas of the department. This team manages all IT operations for the company and acts as the liaison between the IT Department and business management. Writing of correspondence, documentation, project proposals, employee evaluations, task assignments, and other forms of writing are everyday activities for these professionals.

Consultants, in this example, are IT professionals who do not work for the company as employees; instead, they are employed as contractors temporarily to assist the company in achieving specific goals. These IT professionals are often off site and work remotely with the internal IT staff. Consultants are often involved in writing activities in similar ways: as managers, as business professionals themselves, and as members of the teams they work with within the company.

IT Departments are usually segmented into teams, each focusing on specific areas of the business's technological needs. For example, the Software Development team would include Computer Programmers, Web Developers, Quality Assurance Engineers, Test Engineers, Software Engineers, etc. This team would be responsible for creating and maintaining all software in the business, from the company website to financial, database, system, and user applications. In IT environments such as this, written communication is very common within the teams, the IT Department, and the entire business. Team members may correspond with others in the company and with customers, contractors, vendors, and the public outside of the company. Within the context of their day-to-day work, these professionals are often tasked with maintaining documentation, writing instructions and results of testing, updating the status of projects within project management software, and responding to questions and concerns of others through written communication.

Project Lifecycles in Computer Science

In Computer Science, there are established approaches to managing projects, which vary depending on the type of project. Within these projects, writing is a crucial element. For example, written documentation will be needed for a new computer network, database, a data analytics project, a software system, etc. This chapter will consider a software development project for demonstration purposes. Keep in mind that while there are many other types of projects in the field, the steps to manage CS projects generally follow similar principles as the example we will explore here.

The Software Development Lifecycle (SDLC) is a well-defined set of steps commonly used to organize and manage software projects. Figure 4.2 provides a visual representation of the SDLC.

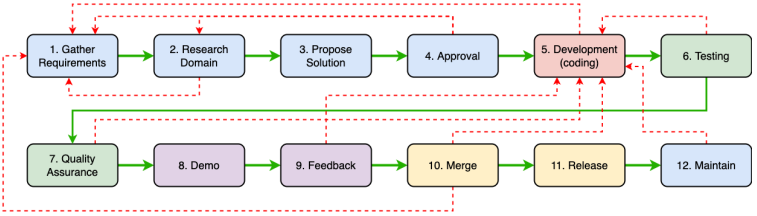


Figure 4.2: Software Development Life Cycle (SDLC), John Gordon, Salt Lake Community College.

Following Figure 4.2, the steps of the SDLC are as follows:

1. Gather Requirements

- Various approaches are used to gather project requirements, such as interviews, data sampling, user observation, surveys, brainstorming, use cases, focus groups, and prototyping to gather details about the project to develop a formal requirements document. This document will include all technical information determined by the requirements gathering process. Requirements documents will be examined in detail in the next section of this chapter.

2. Research the Domain

    - Understanding the project's domain involves research to ensure that the development team is familiar with the basis of the project within the context of the business or problem. Examples of this might include educating the developers about the specific types of data that will be processed with the software, business rules, calculations, workflows, thresholds, and decisions that the software will need to handle in the business context—notice Figure 4.2, the dashed line that directs the flow back to requirements. In learning the domain, there are occasions when questions arise that require the process to return to the requirements step for clarification or additional information.

3. Propose a Solution

    - The development of a proposed solution combines the requirements and domain research to create a Project Proposal Document (PPD). The PPD is written with a non-technical audience in mind. This document includes summarized findings from requirements gathering, diagrams, images, and possibly videos to provide the non-technical audience

with a clear understanding of the proposed solution. We will examine the PPD later in this chapter.

4. Customer Approval

    - Once the proposal is complete, it is presented to the customer for review and approval. This often involves written communications in electronic messaging, meeting agendas, presentations, and acceptance documents. In some cases, proposals are competitive; they are submitted in response to the customer's request (RFP). This is called a bid process. If this is the case, the customer will select one of the proposals as the winner of the bid process. Notice, again, that Figure 4.2 indicates that the flow of the SDLC process may need to return to requirements gathering. This is often when the customer reveals additional requirements and changes during during this approval step.

5. Development (Coding)

    - When the customer accepts the proposal, writing the code for the solution may begin. Computer programming involves a great deal of writing—not only writing the code in the programming language(s) of choice, but also writing comments (non-executable statements) within the code that document its logic and maintain ongoing project management documentation, usually stored inside a project management software system. This development step is critical in the SDLC when changes may be necessary. Figure 4.2 indicates the possibility of returning to requirements gathering. While all the planning may be detailed, implementing the idea may

also reveal challenges. All of the details of these challenges are recorded in writing in the project management system for review by development managers and the customer for resolution.

6. Testing the Solution

    - As components of the software system are developed and coded, they are forwarded to a testing team to test the solution. Test Engineers write additional documentation detailing the test procedures and their testing steps, outcomes, and recommendations for corrections or improvements. This documentation is shared with the programmers and managers. Steps 5 and 6 are often iterative; that is, Programmers and Test Engineers work together to produce the most accurate coded solution possible that usually involves a repeated cycle of coding and testing. Because of this, as indicated in Figure 4.2, the process may circle between these two steps for some time. Ideally, during this loop, both the programmers and testers write notes in the project management software to document their process, observations, solutions, and progress.

7. QA the Solution

    - When components have been successfully tested and signed off by the testing team, they advance to Quality Assurance (QA), where QA Engineers validate the functionality with the documented requirements, business rules, and user feedback. Throughout their process, QA Engineers continuously update project documentation with notes regarding the outcomes of their evaluations. Like the loop between Steps 5 and 6,

the QA process could also cause the process to return to the programming teams for adjustments. Written documentation is critical to track changes, maintain transparency among the groups, and keep all interested parties informed.

8. Demonstrate the Solution to the Customer

    - At this point in the process, software components are presented to the customer; this step is often called a user demo. During the demo, customer requirements from Step 1 of the SDLC are shown in the context of the working solution. During the demo, customer responses, questions, and requests for changes are documented in writing and recorded in the project management system.

9. Respond to Customer Feedback

    - Based on the demo results in Step 8, the team will respond accordingly. If the customer approves of the solution, the SDLC can continue to the next step. However, if the customer disapproves of the resolution, many possible steps may need to be taken. Figure 4.2 depicts one example of returning to the development step for changes to the solution. This is only one example, however. It is possible to return to any previous action depending on the circumstances. In any case, written documentation of the customer's feedback and recommendations are carefully documented in the project management software system. That documentation is then used to respond to the customer's feedback accordingly.

10. Merge Solution into Production System

- When the customer accepts the solution, the software developers communicate with other teams in the IT Department who are responsible for deploying the software. Deployment is the process of merging a solution into the production system. The merge step is intermediate and used to confirm that the new solution will function properly before releasing it to users. These steps are documented in the project management system to maintain an audit trail.

11. Release the Solution to Production

    - When the software is released into the production environment, version and installation details are documented to maintain a consistent record of updates and changes to the system. This is often when user documentation is also written or updated and released for users and help-desk technicians to use as reference.

12. Maintain the Solution

    - Over the lifespan of the software, documentation is maintained, updated, and changed as bugs are reported, changes are requested, and updates are applied to the system. When changes are needed, steps of the SDLC will begin restart where appropriate. Figure 4.2 depicts an example of returning to the development step for a change. In this scenario, all of the SDLC steps that follow will be taken as outlined above, including the written documentation to record the changes, results of testing, etc.

As you can see from this overview of the SDLC, writing is a critical part of each process step. A fully realized SDLC project will involve various forms of writing throughout each SDLC

step. Depending on the scale and complexity of the project, the project's duration can vary widely from a few weeks to many years.

Requirements Documents

Requirements Documents are formal written documents that outline, in detail, the technical and logical requirements of a project. This document is written during Steps 1 and 2 of the SDLC. The intended audience of a requirements document includes anyone involved in the project who needs a deep technical understanding. This document is often used as the primary outline of a project for the technical team, as the source of task assignments, and as the working document for team members.

There are various requirements documents, each structured differently to serve the needs of different projects such as consumer products or services, marketing campaigns, and projects that fit a business's specific needs. For the sake of focus, we will explore one type of requirements document here, the Software Requirements Specification (SRS), keeping in mind that this is one of many types that may be encountered.

Requirements Gathering Approach

One of the first challenges to producing an SRS document is determining the approach. How do we gather requirements and develop an understanding of the domain of a business? There is no single answer to this question. The method depends on the circumstances, the level of access available to the company, and their personnel, systems, processes, and data. Given the challenges, it is beneficial to identify some example approaches that can be used individually or in combination depending on the circumstances of any given project. To that end, here is a list of a few of the common approaches used during the first two steps of the SDLC:

- Interviews — Interviewing key personnel in the business is a common approach for gathering requirements and domain information.
- Questionnaires — If the number of personnel is large, questionnaires can be sent to any number of people to gather requirements and domain information.
- Observation — Processes in a business handled by humans, which may become part of a new software system, are often best understood and documented through observation.
- Brainstorming — Gathering a group of crucial personnel together and brainstorming the new system's needs is often a fruitful approach for gathering requirements and understanding the business domain.
- Document Review — There may be existing documentation, instructions, diagrams, etc., that the software engineer can review to gather information about

the requirements.

- Sampling — When project requirements include complex data or processes, taking samples of data and experimenting with business rules with those samples often reveal a great deal of technical detail about the data and processes.
- Prototyping — Software Engineers often create a simplified solution prototype for the customer to review to help confirm the engineer's understanding of the requirements and domain.

Software Requirements Specification (SRS)

A Software Requirements Specification (SRS) is a document that provides a detailed description of a software development project. The SRS outlines the technical requirements of the proposed system, defines the purpose of the system and its components, and includes sufficient detail for technical teams to build the system. The SRS should provide a complete overview of the project and will be used by everyone involved in the project to aid in its successful completion. Once the SRS is complete, a PPD would be produced that summarizes the findings of the SRS. The PPD would be presented to the customer for approval. See the next section of this chapter for a discussion of PPDs. We will explore these two documents using a fictitious project scenario for demonstration purposes.

Scenario

ABC Consulting Services, LLC, has been asked to propose a software solution for a new call center opening in Salt Lake City. The company needs a system for their call center agents to record customer information and receive customer support phone calls. The call center operates three shifts to handle 24/7 customer calls. The company owners have contracted ABC to conduct a

requirements study and subsequently propose a software solution for their needs.

The size of an SRS document is dependent on the scale and complexity of the project. The document is usually produced by a team of professionals who contribute to the specifications based on their areas of expertise. A small project may warrant an SRS of ten pages, whereas a large-scale project may require hundreds. In any case, the goal is to produce a detailed project specification.

ABC Consulting will produce an SRS and PPD for the customer as deliverables in our example scenario. These documents will be the product of the consulting team working through Steps 1 and 2 of the SDLC process shown in Figure 4.2. While the approaches and content can vary by project, the following is an example of an SRS.

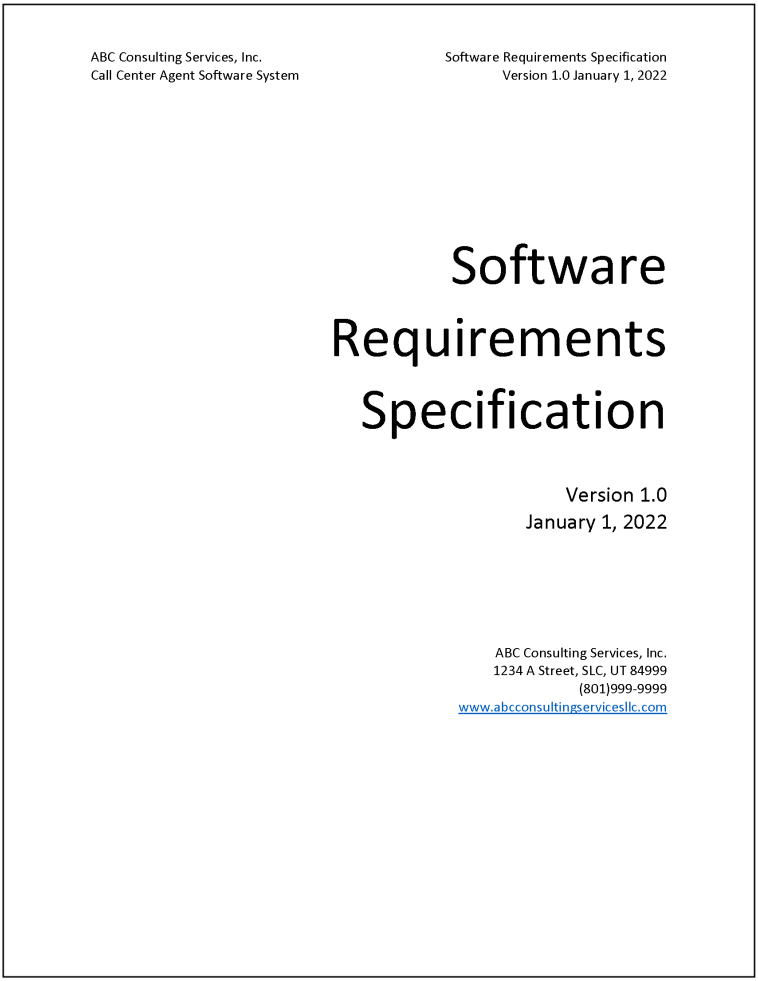
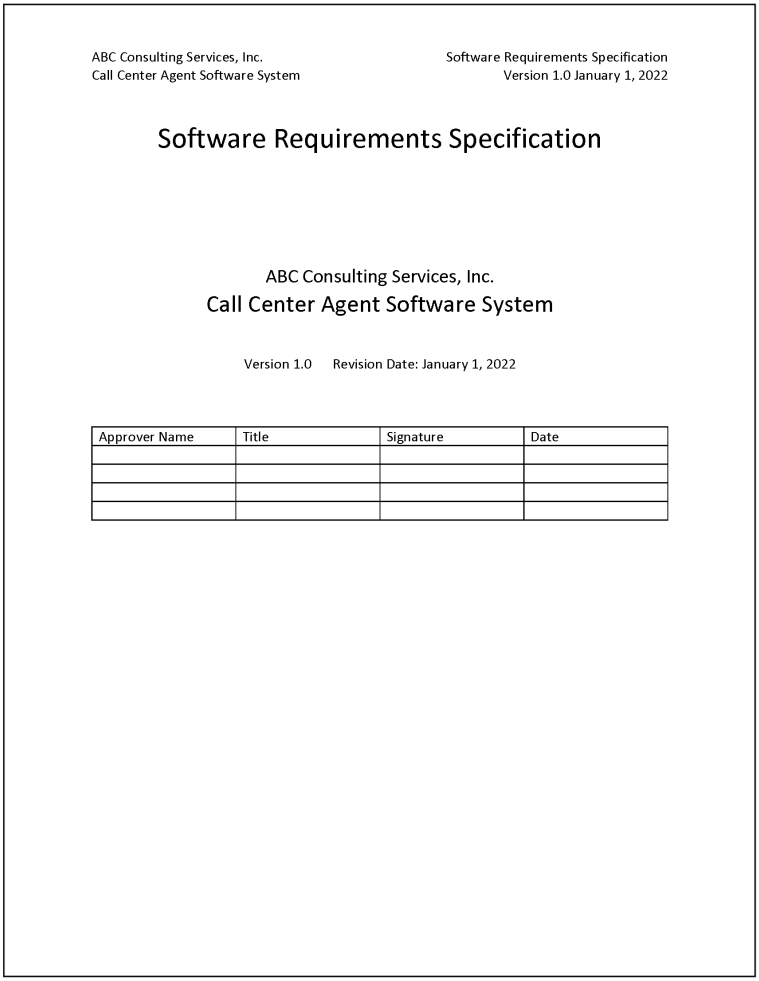


Figure 4.3: SRS Cover Page, John Gordon, Salt Lake Community College.

The SRS is a formal document written for approval by customer representatives. Figures 4.3 and 4.4 depict a standard format for the cover and approval pages. In addition to identifying the document's purpose, it lists the authors of the SRS and

their identifying and contact information. An approval page is provided to document the customer's approval when they approve the SRS.



ABC Consulting Services, Inc.
Call Center Agent Software System

Software Requirements Specification
Version 1.0 January 1, 2022

Software Requirements Specification

ABC Consulting Services, Inc.
Call Center Agent Software System

Version 1.0 Revision Date: January 1, 2022

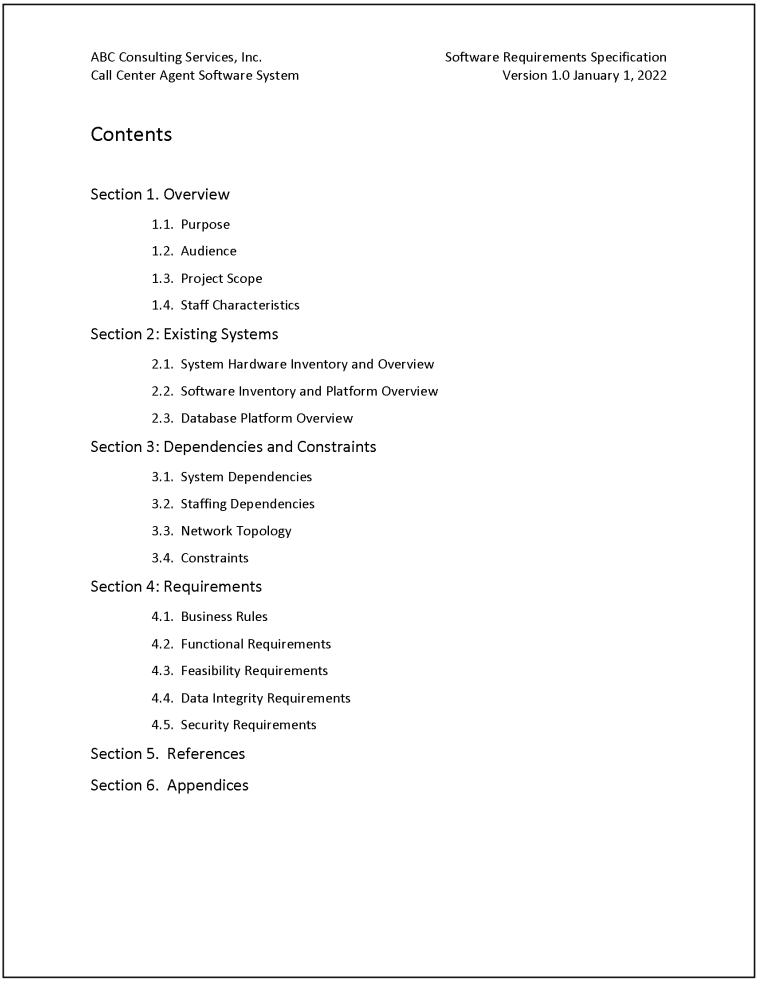
Approver Name	Title	Signature	Date

Figure 4.4: SRS Approval Page, John Gordon, Salt Lake Community College.

The contents of the SRS vary depending on the scope and size of the project. The detail needed between small-scale and large-scale projects is the same—a detailed account of the requirements. The difference from project to project is in the context of the project. For example, the customer's request may require the new software to interact with the company's existing computers, networks, and databases. In contrast, other projects may also require entirely new hardware and database software. As a result, the consulting team will structure the SRS to suit the project's needs.

To prepare for writing an SRS, a format of the document can be chosen. A standard section-based structure is often used to group related information. Also, while there may be variation in content, standard sections in an SRS often include an overview, an exploration of existing systems, dependencies, constraints, requirements, and supporting documentation, as shown below.

Section 1 of an SRS document presents the overall purpose of the project and the software requested. It also addresses the project's audience, scope, and staffing considerations. It is essential to the project's success for the overview to be well written and accurately describe the project.



ABC Consulting Services, Inc.
Call Center Agent Software System

Software Requirements Specification
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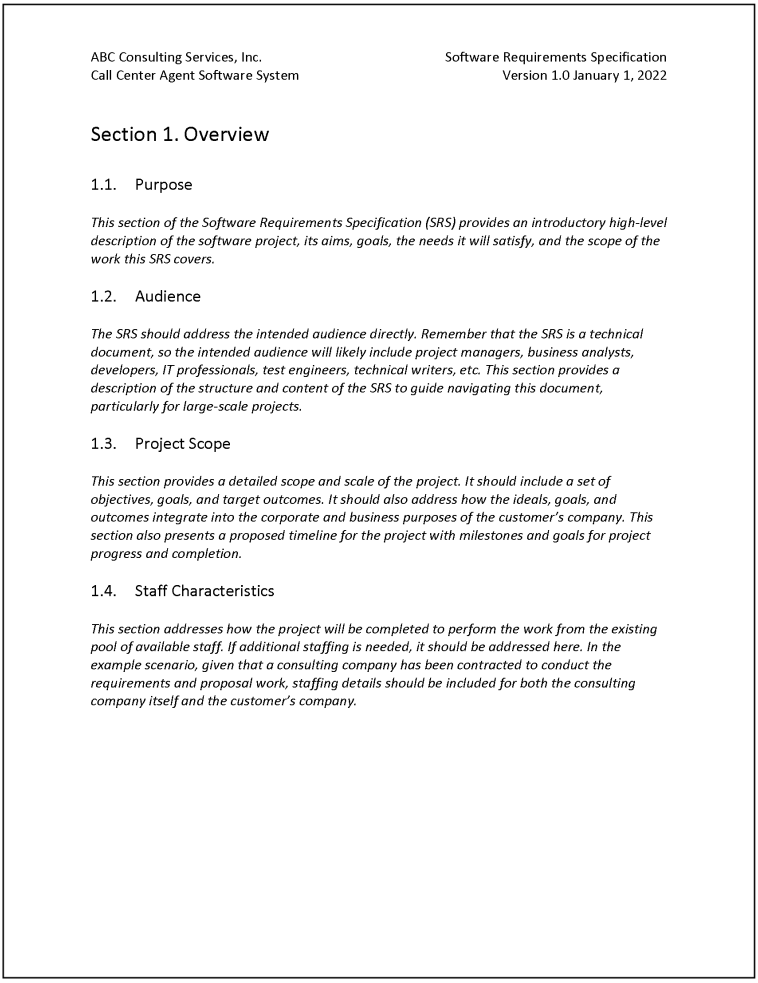
Contents

Figure 4.5: SRS Contents Page, John Gordon, Salt Lake Community College.



ABC Consulting Services, Inc.
Call Center Agent Software System

Software Requirements Specification
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Section 1. Overview

1.1. Purpose

This section of the Software Requirements Specification (SRS) provides an introductory high-level description of the software project, its aims, goals, the needs it will satisfy, and the scope of the work this SRS covers.

1.2. Audience

The SRS should address the intended audience directly. Remember that the SRS is a technical document, so the intended audience will likely include project managers, business analysts, developers, IT professionals, test engineers, technical writers, etc. This section provides a description of the structure and content of the SRS to guide navigating this document, particularly for large-scale projects.

1.3. Project Scope

This section provides a detailed scope and scale of the project. It should include a set of objectives, goals, and target outcomes. It should also address how the ideals, goals, and outcomes integrate into the corporate and business purposes of the customer's company. This section also presents a proposed timeline for the project with milestones and goals for project progress and completion.

1.4. Staff Characteristics

This section addresses how the project will be completed to perform the work from the existing pool of available staff. If additional staffing is needed, it should be addressed here. In the example scenario, given that a consulting company has been contracted to conduct the requirements and proposal work, staffing details should be included for both the consulting company itself and the customer's company.

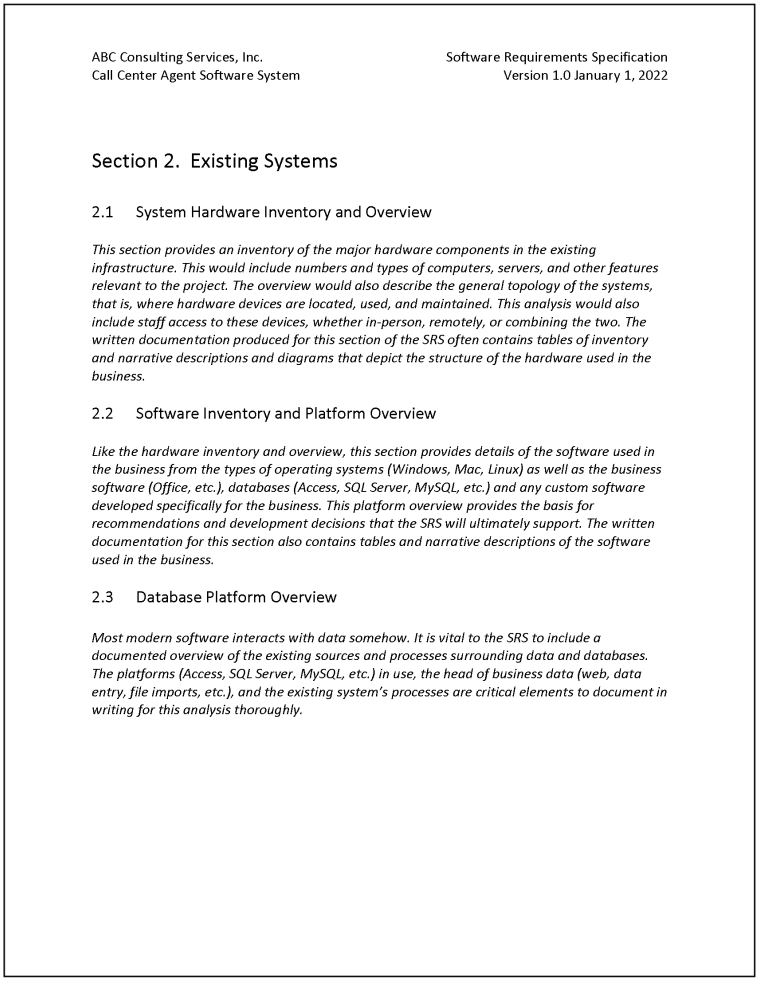
Figure 4.6: SRS Overview Page, John Gordon, Salt Lake Community College.

When developing new systems for a business, it is critical to consider processes and procedures that may already exist there. This genuine consideration requires focused attention and analysis during this process and is a vital part of the SDLC

Part 2 Domain Research. The domain of the business must be considered for a new system to integrate well into the business's existing infrastructure. This applies to existing hardware and software and to the other processes handled by humans and equipment if those processes will be affected by the new system. Well-written details surrounding the domain often reveal challenges and needs that are easy to overlook otherwise. This is an example of discovery during the SDLC research steps that can cause the process to loop between stages, and it is why well-written documentation is vital to the success of projects.

Section 2 of the SRS document outlines existing systems. This section will vary widely from project to project because existing hardware, software, and processes are often very different from one project to the next. Overall, this section provides a written inventory and overview of existing components and software and describes how those elements interact to accomplish their intended tasks. This section combines written documentation, diagrams, and process flowcharts to aid in understanding the existing infrastructure.

Section 3 is directly related to Section 2 and acts as a bridge between the existing and new systems. Dependencies are how the various components rely on each other to operate within the business context. Identifying and documenting these dependencies, primarily related to the proposed new system, is critical for SDLC Steps 1 and 2.



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Section 2. Existing Systems

2.1 System Hardware Inventory and Overview

This section provides an inventory of the major hardware components in the existing infrastructure. This would include numbers and types of computers, servers, and other features relevant to the project. The overview would also describe the general topology of the systems, that is, where hardware devices are located, used, and maintained. This analysis would also include staff access to these devices, whether in-person, remotely, or combining the two. The written documentation produced for this section of the SRS often contains tables of inventory and narrative descriptions and diagrams that depict the structure of the hardware used in the business.

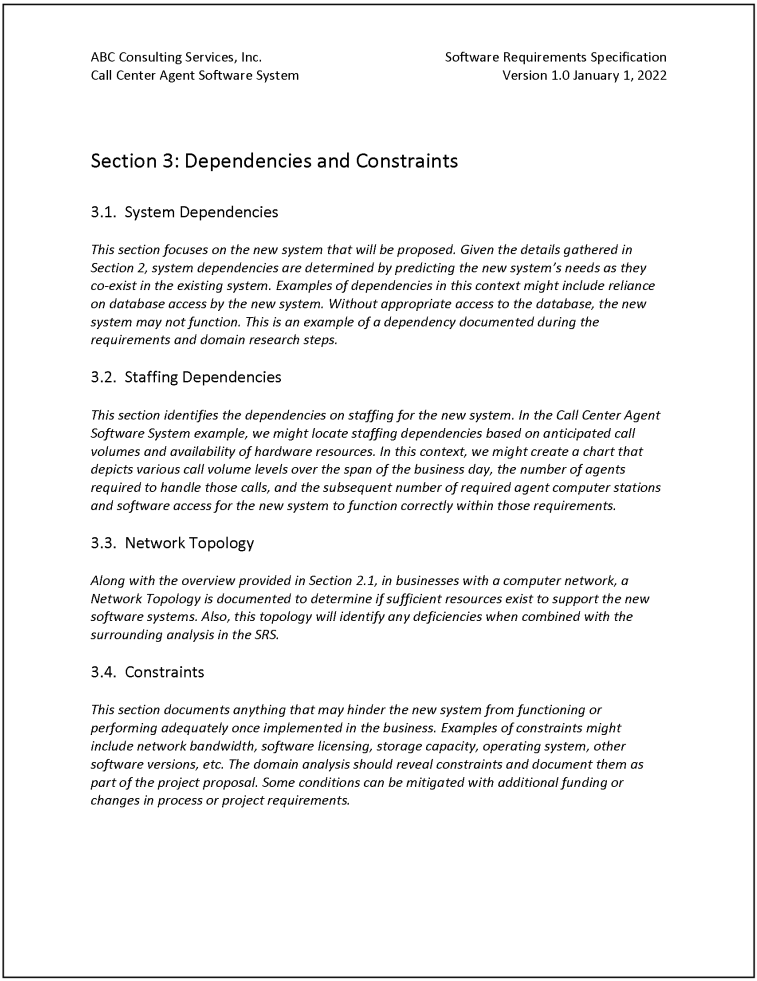
2.2 Software Inventory and Platform Overview

Like the hardware inventory and overview, this section provides details of the software used in the business from the types of operating systems (Windows, Mac, Linux) as well as the business software (Office, etc.), databases (Access, SQL Server, MySQL, etc.) and any custom software developed specifically for the business. This platform overview provides the basis for recommendations and development decisions that the SRS will ultimately support. The written documentation for this section also contains tables and narrative descriptions of the software used in the business.

2.3 Database Platform Overview

Most modern software interacts with data somehow. It is vital to the SRS to include a documented overview of the existing sources and processes surrounding data and databases. The platforms (Access, SQL Server, MySQL, etc.) in use, the head of business data (web, data entry, file imports, etc.), and the existing system's processes are critical elements to document in writing for this analysis thoroughly.

Figure 4.7: SRS Existing Systems Page, John Gordon, Salt Lake Community College.



ABC Consulting Services, Inc.
Call Center Agent Software System

Software Requirements Specification
Version 1.0 January 1, 2022

Section 3: Dependencies and Constraints

3.1. System Dependencies

This section focuses on the new system that will be proposed. Given the details gathered in Section 2, system dependencies are determined by predicting the new system's needs as they co-exist in the existing system. Examples of dependencies in this context might include reliance on database access by the new system. Without appropriate access to the database, the new system may not function. This is an example of a dependency documented during the requirements and domain research steps.

3.2. Staffing Dependencies

This section identifies the dependencies on staffing for the new system. In the Call Center Agent Software System example, we might locate staffing dependencies based on anticipated call volumes and availability of hardware resources. In this context, we might create a chart that depicts various call volume levels over the span of the business day, the number of agents required to handle those calls, and the subsequent number of required agent computer stations and software access for the new system to function correctly within those requirements.

3.3. Network Topology

Along with the overview provided in Section 2.1, in businesses with a computer network, a Network Topology is documented to determine if sufficient resources exist to support the new software systems. Also, this topology will identify any deficiencies when combined with the surrounding analysis in the SRS.

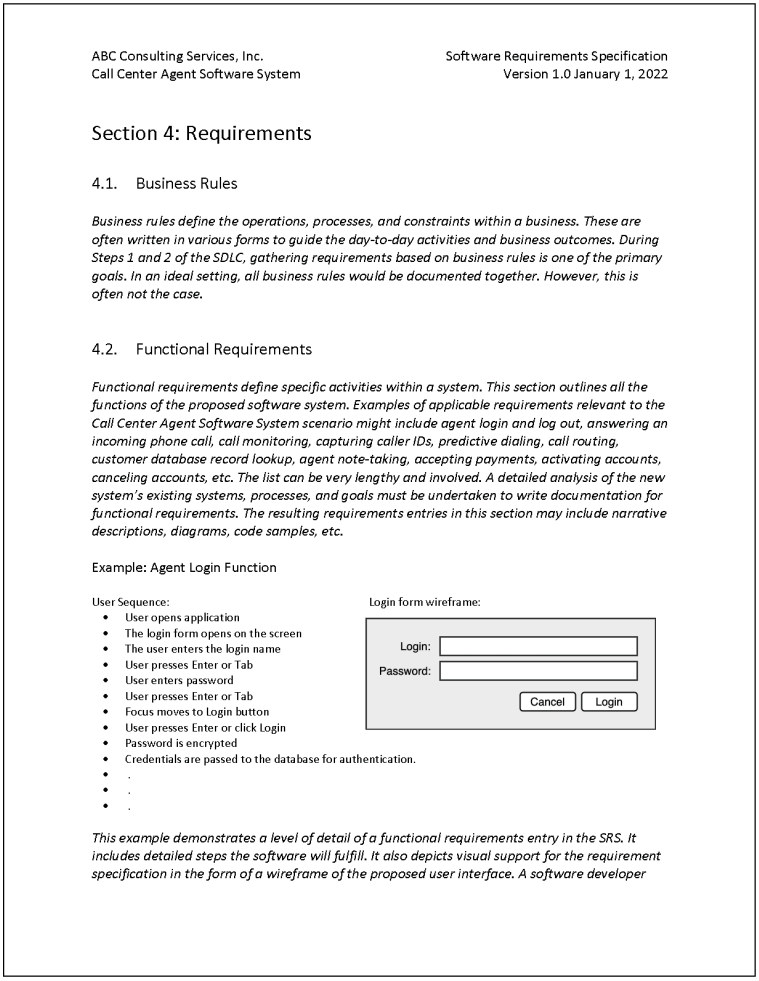
3.4. Constraints

This section documents anything that may hinder the new system from functioning or performing adequately once implemented in the business. Examples of constraints might include network bandwidth, software licensing, storage capacity, operating system, other software versions, etc. The domain analysis should reveal constraints and document them as part of the project proposal. Some conditions can be mitigated with additional funding or changes in process or project requirements.

Figure 4.8: SRS Dependencies Page, John Gordon, Salt Lake Community College.

Section 4 of the SRS is generally the most detailed and lengthy part of the requirements document. This is where exact software product requirements are documented and become the source of task assignments later when the actual project

work begins. Figure 4.9 demonstrates some of the specific requirements needed in an SRS. These types are selected based on the needs and goals of the project.



ABC Consulting Services, Inc.
Call Center Agent Software System

Software Requirements Specification
Version 1.0 January 1, 2022

Section 4: Requirements

4.1. Business Rules

Business rules define the operations, processes, and constraints within a business. These are often written in various forms to guide the day-to-day activities and business outcomes. During Steps 1 and 2 of the SDLC, gathering requirements based on business rules is one of the primary goals. In an ideal setting, all business rules would be documented together. However, this is often not the case.

4.2. Functional Requirements

Functional requirements define specific activities within a system. This section outlines all the functions of the proposed software system. Examples of applicable requirements relevant to the Call Center Agent Software System scenario might include agent login and log out, answering an incoming phone call, call monitoring, capturing caller IDs, predictive dialing, call routing, customer database record lookup, agent note-taking, accepting payments, activating accounts, canceling accounts, etc. The list can be very lengthy and involved. A detailed analysis of the new system's existing systems, processes, and goals must be undertaken to write documentation for functional requirements. The resulting requirements entries in this section may include narrative descriptions, diagrams, code samples, etc.

Example: Agent Login Function

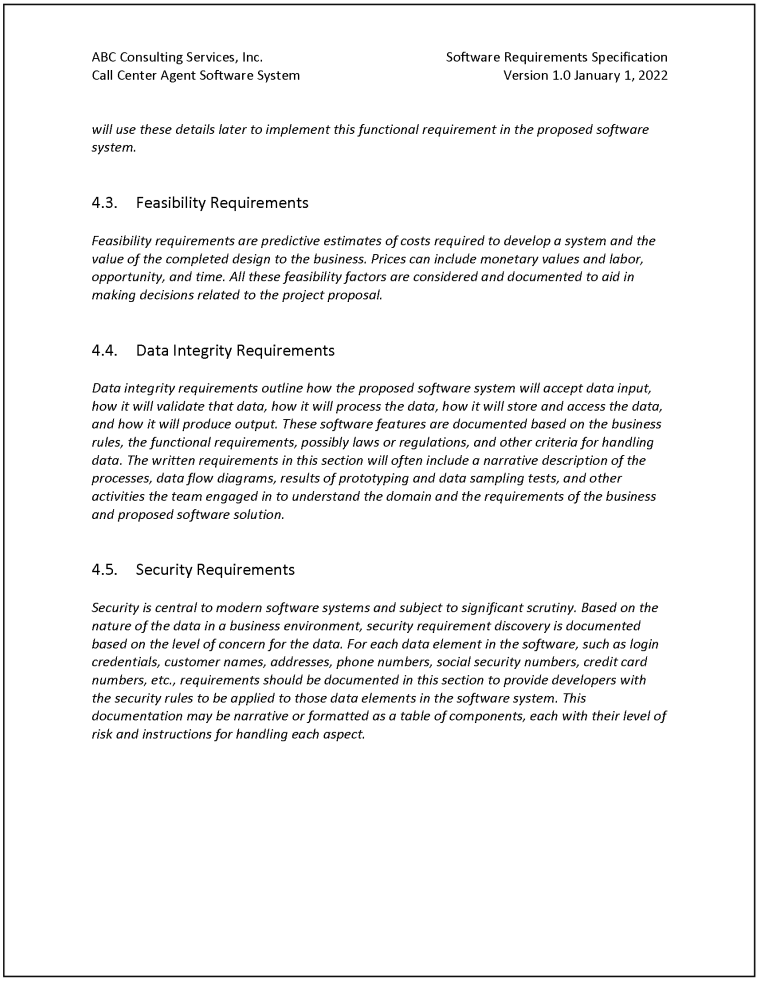
User Sequence:

- User opens application
- The login form opens on the screen
- The user enters the login name
- User presses Enter or Tab
- User enters password
- User presses Enter or Tab
- Focus moves to Login button
- User presses Enter or click Login
- Password is encrypted
- Credentials are passed to the database for authentication.
- .
- .
- .

Login form wireframe:

This example demonstrates a level of detail of a functional requirements entry in the SRS. It includes detailed steps the software will fulfill. It also depicts visual support for the requirement specification in the form of a wireframe of the proposed user interface. A software developer

Figure 4.9: SRS Requirements Page, John Gordon, Salt Lake Community College.



will use these details later to implement this functional requirement in the proposed software system.

4.3. Feasibility Requirements

Feasibility requirements are predictive estimates of costs required to develop a system and the value of the completed design to the business. Prices can include monetary values and labor, opportunity, and time. All these feasibility factors are considered and documented to aid in making decisions related to the project proposal.

4.4. Data Integrity Requirements

Data integrity requirements outline how the proposed software system will accept data input, how it will validate that data, how it will process the data, how it will store and access the data, and how it will produce output. These software features are documented based on the business rules, the functional requirements, possibly laws or regulations, and other criteria for handling data. The written requirements in this section will often include a narrative description of the processes, data flow diagrams, results of prototyping and data sampling tests, and other activities the team engaged in to understand the domain and the requirements of the business and proposed software solution.

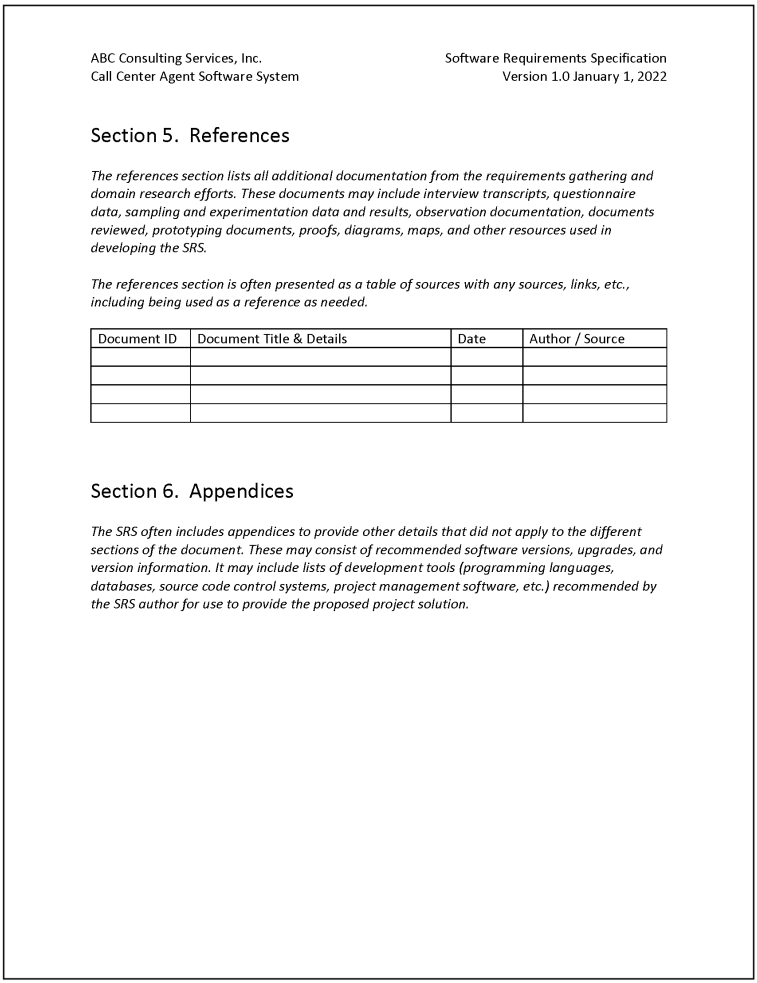
4.5. Security Requirements

Security is central to modern software systems and subject to significant scrutiny. Based on the nature of the data in a business environment, security requirement discovery is documented based on the level of concern for the data. For each data element in the software, such as login credentials, customer names, addresses, phone numbers, social security numbers, credit card numbers, etc., requirements should be documented in this section to provide developers with the security rules to be applied to those data elements in the software system. This documentation may be narrative or formatted as a table of components, each with their level of risk and instructions for handling each aspect.

Figure 4.10: SRS Page, John Gordon, Salt Lake Community College.

Section 5 and **Section 6** shown in Figure 4.11 demonstrate additional types of documentation that may appear in an SRS. These provide space for supporting documentation and project-tracking details necessary for the project's success.

Other supporting sections that are often in SRS documents, beyond the References and Appendices sections, include glossaries, revision histories, requirements matrices, analysis models, test performance metrics, and others.



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Section 5. References

The references section lists all additional documentation from the requirements gathering and domain research efforts. These documents may include interview transcripts, questionnaire data, sampling and experimentation data and results, observation documentation, documents reviewed, prototyping documents, proofs, diagrams, maps, and other resources used in developing the SRS.

The references section is often presented as a table of sources with any sources, links, etc., including being used as a reference as needed.

Document ID	Document Title & Details	Date	Author / Source

Section 6. Appendices

The SRS often includes appendices to provide other details that did not apply to the different sections of the document. These may consist of recommended software versions, upgrades, and version information. It may include lists of development tools (programming languages, databases, source code control systems, project management software, etc.) recommended by the SRS author for use to provide the proposed project solution.

Figure 4.11: SRS References and Appendices, John Gordon, Salt Lake Community College.

To conclude this example, it is essential to recognize that each section of the framework presented here may or may not be appropriate for all projects. Also, within each area, the content is directly tied to the actual requirements of each project as well.

The next section of this chapter presents the Project Proposal Document (PPD). If we revisit the steps of the SDLC, we note that the third step is to propose a solution. Once a requirements document is complete, a Project Proposal can then be formulated based on the requirements gathering and domain research.

Project Proposal Documents

The Project Proposal Document (PPD) is often confused with a requirements document. Its purpose, however, is very different from a requirements document. As revealed above, a requirements document is technical and lengthy. Also, the audience for a requirements document includes technical professionals to construct the solution. On the other hand, a PPD is intended for non-technical decision makers, such as company owners, executives, managers, and other business professionals. Also, PPDs are written after SRS documents have been completed. PPDs provide summarized details of the proposed solution, feasibility overview, timeline, and costs based on the requirements gathering and domain research documented in the SRS.

The format of a PPD is reasonably standard, with some variation across project types and industries. Software PPDs provide a brief overview of the SRS document's findings and include legally binding agreement language. The following example provides a basic framework for a PPD and some embedded notes regarding each section in the document.

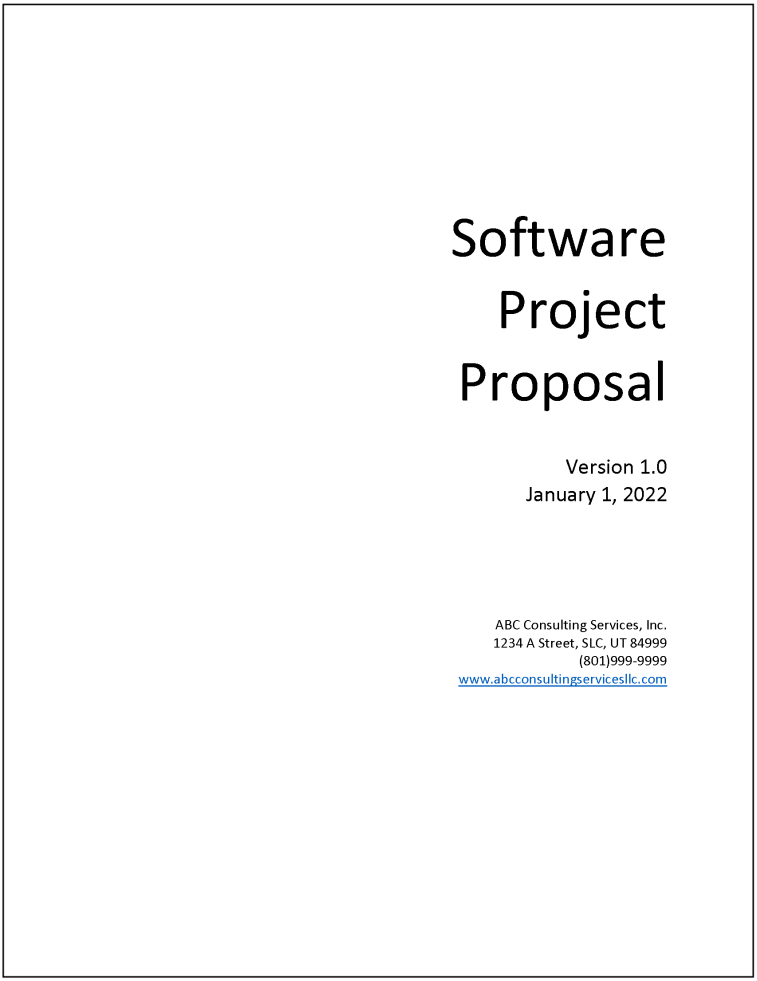
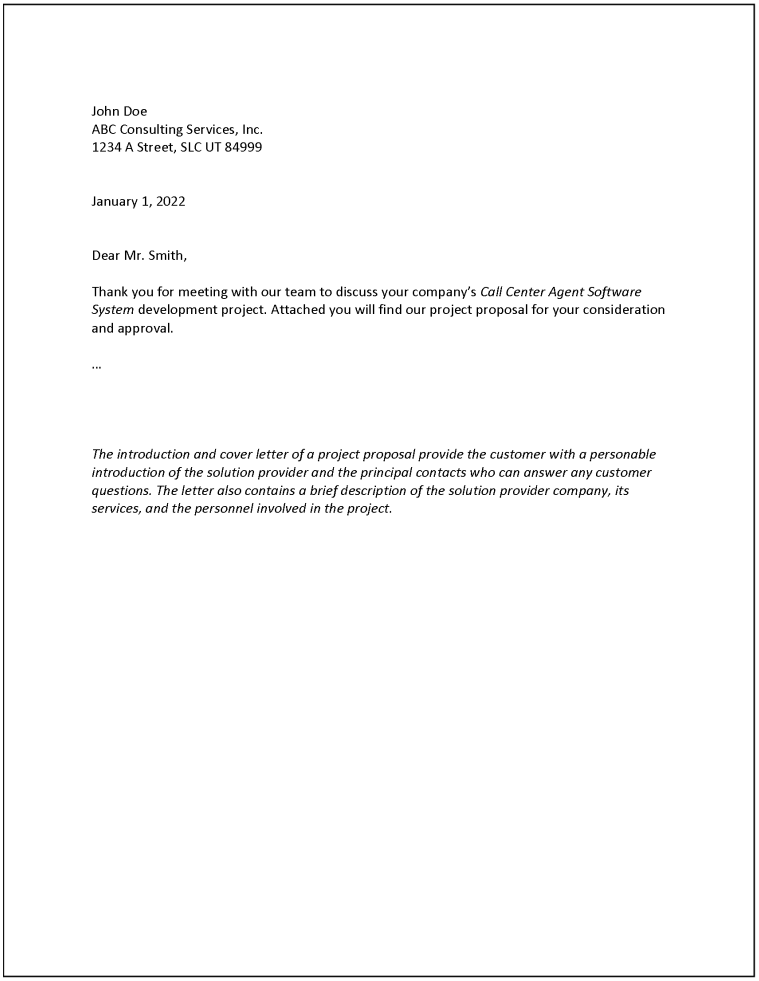


Figure 4.8: PPD Cover Page, John Gordon, Salt Lake Community College.


John Doe
ABC Consulting Services, Inc.
1234 A Street, SLC UT 84999

January 1, 2022

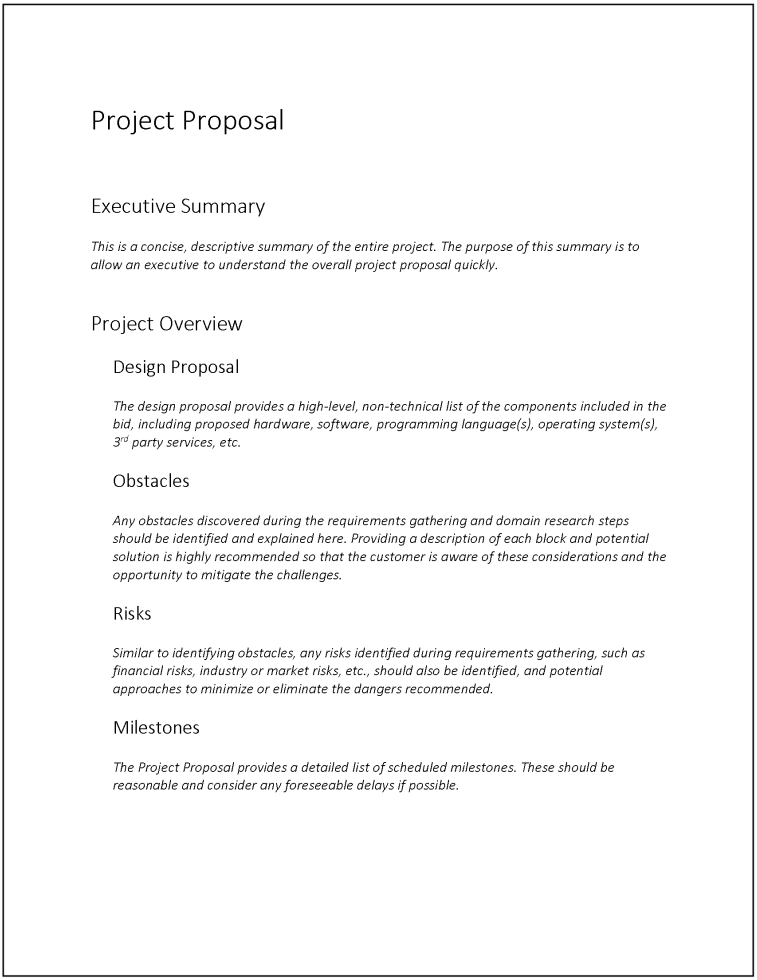
Dear Mr. Smith,

Thank you for meeting with our team to discuss your company's *Call Center Agent Software System* development project. Attached you will find our project proposal for your consideration and approval.

...

The introduction and cover letter of a project proposal provide the customer with a personable introduction of the solution provider and the principal contacts who can answer any customer questions. The letter also contains a brief description of the solution provider company, its services, and the personnel involved in the project.

Figure 4.9: PPD Cover Letter Page, John Gordon, Salt Lake Community College.



Project Proposal

Executive Summary

This is a concise, descriptive summary of the entire project. The purpose of this summary is to allow an executive to understand the overall project proposal quickly.

Project Overview

Design Proposal

The design proposal provides a high-level, non-technical list of the components included in the bid, including proposed hardware, software, programming language(s), operating system(s), 3rd party services, etc.

Obstacles

Any obstacles discovered during the requirements gathering and domain research steps should be identified and explained here. Providing a description of each block and potential solution is highly recommended so that the customer is aware of these considerations and the opportunity to mitigate the challenges.

Risks

Similar to identifying obstacles, any risks identified during requirements gathering, such as financial risks, industry or market risks, etc., should also be identified, and potential approaches to minimize or eliminate the dangers recommended.

Milestones

The Project Proposal provides a detailed list of scheduled milestones. These should be reasonable and consider any foreseeable delays if possible.

Figure 4.10: PPD Page, John Gordon, Salt Lake Community College.

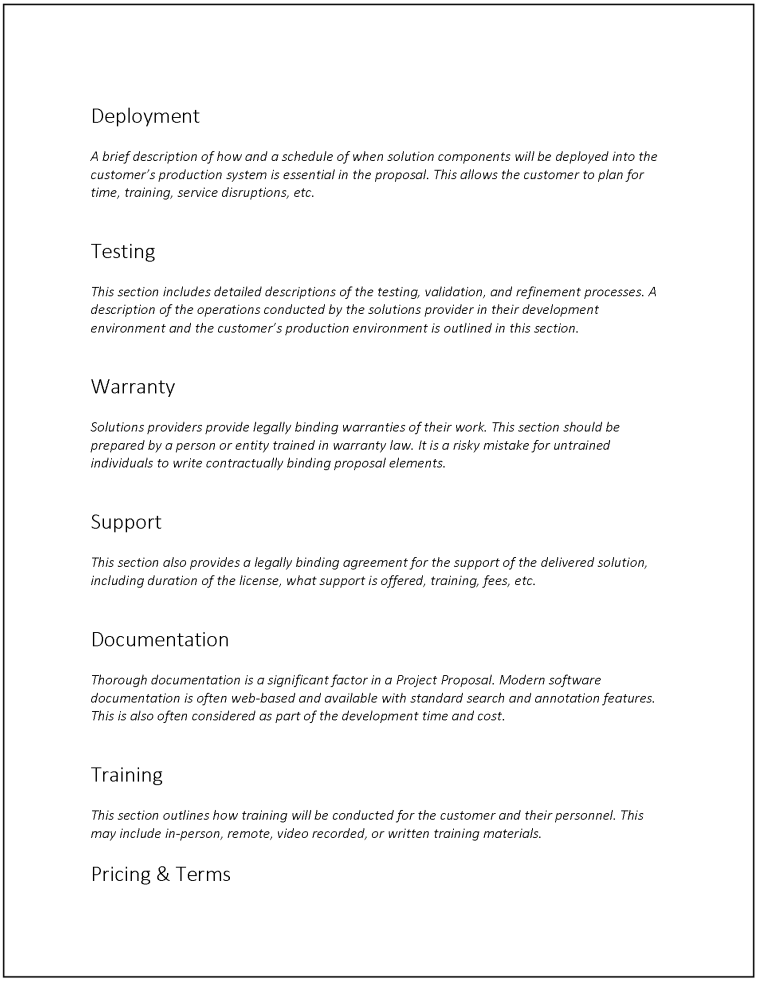


Figure 4.11: PPD Page, John Gordon, Salt Lake Community College.

The proposed costs (a.k.a., the bid) and payment terms are values provided to the customer for them to consider for approval. Payment terms are often based on the milestones outlined above, but various approaches to devising payment and terms plans exist.

Contact Information

Even though solution provider contact information is provided at the beginning of the proposal, it is also essential to list critical contacts at the end. This list should include all crucial members of the solutions provider team to contact appropriate team members with their questions.

Signatures

A Project Proposal is a legally binding document and serves as acceptance of the project by the customer. In this section, signatures are collected from representatives of both the customer and the solution provider to indicate approval of the proposal, which binds the two parties to the project.

Figure 4.12: PPD Page, John Gordon, Salt Lake Community College.

Conclusion

It is likely no surprise that, given the team-based nature of most IT Departments, collaborating with others is a daily occurrence. Also, given the increasingly dispersed and remote forms of work in this field, written communication in emails, team collaboration software (MS Teams, Slack, Discord, Zoom, etc.), and documentation is such a joint daily event that it is often taken for granted. In collaborative spaces such as these, clear, concise writing is even more critical. CS professionals often write about highly complex topics in very brief sentences, often shared with many people. The opportunity for confusion and misinterpretation is very high. It is in the professional's best interests to learn to write in these digital forms as efficiently and precisely as possible.

By now, it is also probably obvious that it is doubtful that a person would be responsible for conducting all of the research and writing of the requirements and proposal documents introduced in this chapter. The time investment to complete these processes can be short, finished in a matter of a few days, or it can take months of work by a team of people, depending on the scale of the project. In any case, these documents require the expertise of various people: IT professionals, legal, managers, accounting and finance, business analysts, marketing, administrative staff, and others. As a technical writer, you may be tasked with conducting portions of the research and parts of the writing, and then the fruits of your labor will be combined with the work of others to construct these documents.

References

Vee, Annette. Coding Literacy: How Computer Programming is Changing Writing. The MIT Press, 2017.

PART V
CITATION & COPYRIGHT

Typically the primary content of your document should be created by you and be your own original work. However, for research purposes or other reasons you may want to incorporate text, images, video or audio from another source. If you incorporate external materials, you need to make sure that the content is credited and available for reuse. This section contains a few guidelines for how to integrate external materials appropriately. This is called citation.

Citing your sources, also called referencing your sources (and sometimes called documenting your sources) is important for multiple reasons. First it lends credibility to your own writing by showing that you have used trustworthy sources and original research in an ethical way to inform your own ideas. It also helps readers find the sources of your information–your evidence for why you argue for a certain position or why you put forth a certain hypothesis.

Citation styles are standardized. In your high school or other previous English classes you may have learned about MLA (Modern Language Association) style citations. In technical writing the default standard is APA (American Psychological Association) style; however, different career fields use different citation standards. For example, in many of the sciences the CSE (Council of Science Editors) style is used.

Finally, remember anything written down, recorded, or posted to the web is under copyright. You cannot use something that is copyrighted without *written* permission from the owner.

Using material from other sources

If you integrate text from an external source (not your own ideas but someone else's ideas) into your writing remember you must cite that source. The main goals of any citation (whether formal or informal) are to a) signal that the ideas or content are not originally yours and b) give your audience a way to find the original information. To achieve these two goals, there are several different approaches you can take to informal citation

- Integrate the citation into your sentence: According to Wikipedia the word science comes from a Latin word, *scientia,* which has the meaning of "knowledge."
- Mention the source in parentheses after the sentence: The word science comes from the Latin word scientia that means "knowledge" ("Science" in *Wikipedia*).
- Also be sure to use quotation marks to indicate any content that you've used word for word: According to Wikipedia, the word science comes "from the Latin word *scientia*, meaning 'knowledge.' "
- Link to a digital source: If you are creating a digital document, you can connect the user directly to your source with a hyperlink as in the example above.
- Quoted materials should only be used sparingly.

There are standardized ways of citing ideas and materials that are not your own that you use in your

document. You will learn the basics in this chapter.

Quotations and Verbs of Attribution

One important aspect of letting your reader know that you have borrowed information from someone else is to use a verb of attribution. These verbs signal to the reader that the information is not yours.

For example if you wish to summarize what someone else has said on a particular subject you would state some like this:

According to the Mr. Jones, ice melts at a different rate in space then it does on earth.

The word, "according," in this example is the verb of attribution. For a more detailed explanation and a list of examples use an internet search engine to search for "verbs of attribution."

To learn more about using quotations, see "Annoying Ways People Use Quotations" by K. D. Stedman. 2010. Writing Spaces: Readings on Writing, Volume 2. Edited by Charles Lowe and Pavel Zemliansky. (CC BY-NC-ND 4.0) https://wac.colostate.edu/docs/books/writingspaces2/stedman–annoying-ways.pdf

Copyright: Images, Audio, and Video

Most content that is written down, recorded, or posted to the web is under copyright. You cannot use something that is copyrighted without *written* permission from the owner. Many content creators, however, will upload materials to the web *copyright-free*. There are various license types associated with copyright-free content. Some examples include:

- Attribution: Must give appropriate credit to creator
- NonCommercial: Content cannot be used for commercial purposes.
- No Derivative Works: The content can be used, but only in its original form.

In addition to content that is uploaded by a creator to be copyright-free, a lot of media is in the public domain. Typically content enters the public domain when its copyright has expired. Copyright law began in 1924 so works created before then generally are in public domain.

Listed below are a variety of sources where you can search for openly licensed or public domain media. Please be sure to review licensing information on each database so you follow specific rules for use and attribution.

- Images:
  - Creative Commons
  - Pixabay
  - Pexels
  - Unsplash
- Video:

    - Coverr
    - Pexels
    - Pixabay
    - Videezy
    - Videvo
- Audio:
    - Free Stock Music
    - Videvo
    - YouTube Audio Library

Creative Commons and Wikimedia commons allow you search for a variety of freely usable media files.

Copyright: Music

Music is tricky. Typically you cannot copy copyrighted music, even for research purposes, and insert it in your paper, video, etc. PDinfo.com says this about music: “We highly recommend that you consult an attorney or rights clearance agency before you use any music under copyright protection for anything other than your own personal use.”

Fair (Educational) Use

Fair use typically refers to educational use where you are using the quotation, graphic, table, etc. as part of a research or other type of paper for school or research purposes. Here are the guidelines for fair use:

- Do not use commercially (cannot use to make money),
- Must give credit to its creator (cite the source) and
- Generally cannot copy the whole thing. For example it is OK to quote a sentence, or a paragraph, but not whole chapters. This is why you cannot copy a whole picture or a song that is copyrighted.

References and Citation Styles

References (also called citations) occur in two different places in your paper. The first type are in-text references that occur in the text where the quotation or related information is written and usually only contain just enough information to redirect the reader to the end references. End references give all the information the reader needs to find the research source. Sometimes the end references are called works cited, bibliography, or just references.

Although there are many different standard reference styles, the good news is that they all fall into two categories: author-date (or name-year) and citation sequence. APA is an example of an author-date system.

Citations: Numbered (Citation-Sequence) Style

In-text reference

In contrast to author-date systems, citation-sequence systems simply use a number for the in-text reference. This allows for many citations even in a single sentence without making the sentence difficult to read. Because of this many sciences and engineering journals prefer citation-sequence.

Traditionally citation-sequence systems used bracketed numbers, but many journals are moving in the direction of using superscript numerals instead. Again, be aware of the style used in your career field and specific publication. Here are examples of both:

Examples Superscript

Jones[1] findings suggest that Godzilla has not recently terrorized any islands.

It seems that Godzilla has not recently terrorized any islands.[1]

Examples Bracketed Numbers

Jones' [1] findings suggest that Godzilla has not recently terrorized any islands.

It seems that Godzilla has not recently terrorized any islands [1].

Notice the placement of the citation. If the author is named in the sentence the citation goes next to the name. Otherwise it goes at the end.You add numbers in numerical order unless you refer to the same source, then you use the original number. For example if you see the citation numbers 1, 2, 3, 1, 4 this means the author used source number 1 twice in the paper.

Because the in-text citations are numbered, you simply need to jump to that number in the end references to find the information for the source. Here are examples of citation-sequence end references:

Examples

1. Suzuki, I. Rampaging monsters. 2nd Ed. New York, NY: Kaiju Imprints, LTD.; 2017.

2. Jones, L. An update on Godzilla's rampage: Who is in danger? Journal of Scientific Research on Kaiju 2016;8(3):12-36.

3. Telemann, G. Crisis in Tokyo: Godzilla returns once again. Kaiju News 2018 May 3 [accessed 2019 Jan 15]. http://www.kaijunews.com. doi:10.1136/kjn.3307500.119.

Writing tip: If the author uses source number 1 multiple times in the paper, they would need to use the number 1 each time as an in-text citation. In the end references, however, the author would only need to list the source once.

Many writers find they prefer citation-sequence systems to author-date, but the choice is ultimately up to the publisher not the author. Be sure to research your career field and be wary of stylistic requirements of publishers.

Citations: Author-Date (Name-Year) Style

In-text citation

The author-date (also called name-year) system is used in many career fields. The in-text citation usually contains the author's surname and the year of the publication. I may also contain other information such as what page number the quotation was found, etc. Here are some examples of in-text citation:

Examples

Jones' (2016) findings suggest that Godzilla has not recently terrorized any islands.

Recent research suggests that Godzilla has not recently terrorized any islands (Jones 2016).

Many journals will place a comma between the author's surname and the year: (Jones, 2016). This is in keeping with APA style; however, others such as the CSE do not use the comma as in the examples given above. If it becomes necessary to add a page number, you

would add a comma after the year and then list the page number(s) for the source of the quotation: (Jones 2016, 4).

It cannot be stressed enough that you need to research what style is commonly used in your major. Also understand that different journals even in the same field may have different style requirements.

End References

Using the author's surname and date a reader then can refer to the end references and find the full citation. The full citation contains all the necessary information to look up the author's source for the quotation or reference. Here are some examples:

Examples

Jones, L. 2016. An update on Godzilla's rampage: Who is in danger? Journal of Scientific Research on Kaiju, 8 (3), 12-36.

Suzuki, I. 2017. Rampaging monsters. New York, NY: Kaiju Imprints, LTD.

Telemann, G. 2018. Crisis in Tokyo: Godzilla returns once again. Kaiju News [accessed 2019 Jan 15]. http://www.kaijunews.com. doi:10.1136/kjn.3307500.119

In the author-date system references are listed alphabetically by author's surname. Regardless of which system you use notice that, unlike MLA, titles to articles are not put in quotation marks or italicized and only the first word and proper nouns are titled. This is common in most citation styles in STEM fields.

In the case of webpages give date accessed and last edited or published if available. Don't forget to use hanging indent. Finally include the DOI if available. A DOI is a Digital Object Identifier used to permanently identify an article or document and link it to the web; you can find more info on DOI and how to use them on the internet.

Writing tip: Personal communications (email, interview, etc.) are referred to only in in-text references and not in end references. The citation would look like this:

Examples

He told me that Godzilla has not yet destroyed Hawaii (Feb. 3, 2018, email from L. Jones to author; unreferenced).

How to Cite a Picture

How to Cite a Picture (and other Graphics)

First you number and title your figure, then one option is tocredit the source in the caption as in Fig. 1 giving the full citation. Or you can just give the title with the full citation information in the references at the end of your paper as in Fig. 2.

If the picture is your own then the citation depends on whether or not the picture is published. If it is published, use a normal citation with yourself as the author. If it is unpublished, you can cite yourself: picture taken by author along with a date.

For more examples of citing figures and the differences with citing a table see II.V.2 Figures and Tables in this textbook.

Fig. 1. *Crocodile. Source: Everglades NPS, 2005, R. Cammauf. Retrieved on 2015, October 23 from https://www.flickr.com/ (CC Public Domain Mark 1.0.)*

Fig. ***2****. Crocodile.*

—

References:

Crocodile [Image] (2005). Everglades NPS. R. Cammauf. Retrieved on 2015, October 23 from https://www.flickr.com/ (CC Public Domain Mark 1.0.)

Writing tip: If picture is used in a presentation such as a Powerpoint Slide, then you can put the citation in the notes section to avoid clutter.

Tips for Writing Tutors

- When working with students from STEM fields both in-text citations and end references should be one of the first things you help them with.
- Students often forget to cite figures and tables: be sure to help students with those; even if the figure or table is original and not taken from another source, it still needs a caption: See Chapter II: 5.2 Figures and Tables for more information on using proper formatting for captions.
- Often instructors will simply require APA reference style (author-date); however, be aware that many science, technology, and engineering papers use citation-sequence for the references, be sure to check what the instructor requires and be aware of the differences between the two reference styles.

PART VI

UNDERSTANDING CORPORATE CULTURE AND ITS IMPACT ON TECHNICAL WRITING STRATEGIES

Prepared for ENGL 2100 Technical Writing at Salt Lake Community College by Elisa Stone, Professor in the English, Linguistics, & Writing Studies Department. Reviewed by Anne Canavan, Associate Professor in the ELWS Department.

Introduction

PART VII

CIVIC-ENGAGEMENT AND TECHNICAL WRITING

Many of the course sections for Technical Writing are offered as service-learning courses. What is service-learning? Your college experience is to help you have the means to make a living, follow a career path, and find self-fulfillment. Yet it should go beyond these self-oriented goals, it also should prepare you to be a member of society. Perhaps you need to take care of family members, such as your own spouse and children or parents. Yet being a member of society also suggests that you have a civic responsibility as well. Through your service with a non-profit organization and the reflection on that service provided by the writing assignments in class you will come to understand for yourself the reasons for and importance of civic engagement.

"I think service-learning means that community service goes hand-in-hand with getting a higher education. Just as an individual invests in a degree in order to begin or advance their careers, they should also invest in the community where they will advance in age and/or their children will be born into. I think it's especially important to set good examples of community service to younger generations so that they can continue implementing good acts and keep the cycle going." –Previous Student of ENGL 2010

The Salt Lake Community College's vision states that SLCC will be "a model for inclusive and transformative education, strengthening the communities we serve through the success of our students." The values that SLCC has defined to meet this

vision include classroom learning in an atmosphere of respect and empathy for diverse cultures and perspectives, and serving the community—especially in collaboration with community needs.

Service-learning classes seek to fulfill SLCC's vision by allowing you to have direct experience by applying what you are learning about writing to real-world settings. This includes both individual and team projects. You will also be given a chance to reflect on these assignments to consider what you have learned and how you have had an impact in your community.

Students who engage in civic engagement tend to have higher grades, are more likely to graduate, and have a more meaningful class experience. Also the idea that giving back something to the community is just as important as learning in class, and that by doing both you can be prepared to be a good citizen in your community, workplace, and in your life.

Community Engagement in ENGL 2100 Technical Writing

In English 2100 community-engaged learning courses you will learn how to synthesize real-world experiences and academic study by engaging with our respective communities on a larger level.

English 2100 teaches writing for your career whether you will be a scientist, an engineer, a nurse, or a computer programmer. Your class will combine your assignments with service in your community to enrich your learning about writing in your chosen career field.

See the following resources:

https://slcc.pressbooks.pub/openenglishatslcc/chapter/introduction-to-civic-engagement-service-learning/

https://slcc.pressbooks.pub/openenglishatslcc/chapter/service-learning-in-english-composition-courses/

https://slcc.pressbooks.pub/openenglishatslcc/chapter/writing-for-community-change-2/

PART VIII

PROJECT PLANNING

When considering a project, it is best to step back and get a look at all the preparation that goes into the project.

1. Define How Project Relates to Mission Statement and What are the Objectives of the Project
2. Identify Deliverable(s)
3. Define Team Member Responsibilities
4. Create a Project Calendar
5. Create a Work Plan

The next several pages will describe each of these steps. Only after you have created a work plan should you start your project.

Mission Statement and Objectives

Most people jump right in to defining the deliverable of the project–what is the final product, e.g. a document, a product, a service to be offered, etc. is. But before considering the deliverable, step back and think about the overall mission statement and objectives of your organization.

Typically an organization a mission statement that defines the purpose of the organization. Salt Lake Community College's mission statement is, as you would expect, about educating students. Even a class usually has course objectives or learning outcomes about what it hopes students will gain by taking the course that are related to SLCC's mission statement. Individual assignments also have objectives that help you meet the goals, or mission statement, of the course.

So whether it is for class or work, think a minute of how your project will fit in to the overall mission statement of the organization. Does the project fulfill a particular objective that matches the mission statement?

Identify Deliverable(s) and Outcomes

A deliverable is the actual product or service you will provide. For a class it may be a major paper or something you design like a webzine, etc. For a company it may be the product they sell or the service they provide to clients. Now that you have thought about how your project fits with the mission statement and/or objectives for the assignment, class, or company, etc., you need to think about the steps involved in creating your deliverable.

Let's imagine you need to create a pamphlet for a nonprofit organization. You would need to do some research, write the text for the pamphlet, obtain or create the graphics, and design the pamphlet itself to name just a few of the steps involved. Each of these steps can be called outcomes.

Another way to think of outcomes is that they measure progress towards the goal of completing your project. Outcomes must be specific, measurable, and meaningful to the project. Writing the text in the above example is specific, can be measured, and certainly is meaningful to the project.

So as you plan your project also plan your steps, or outcomes that need to be finished in order to complete your project.

Team Member Responsibilities

If you are working on a project by yourself then it is easy–you have all the responsibilities of the project. But when you are on a team then you need to decide who does what. Often you will divide the responsibilities by skill. For example:

- Researcher(s): library, field, and internet research.
- Writer(s): create content.
- Editor(s): organization and style of document. Also proofreading.
- Designer(s): laying out the document, collecting images, making tables, graphs, charts, etc.

You also need *good* communication between team members. Whether you communicate by email, texting, in-person, or a combination of these someone should be responsible for being the contact person. The contact person makes sure everyone receives the needed information and also can act as a liaison between the team and another organization, such as a community partner if you are doing a service-learning project.

> –"In American classrooms, we tend to prize individual accomplishment, yet in professional careers we need to work well with others." Joe Moxley from "Managing Group Projects" found at writingcommons.org

One other important person to select is the coordinator. The

coordinator maintains the project schedule. They also run meetings setting the agenda and making sure that the agenda is met.

These are just some suggested responsibilities. Your team might have other responsibilities, or if the team is small combine some of these responsibilities.

Finally you will want to agree on how to resolve conflicts before they happen. Should decisions be majority or unanimous? Who referees conflicts? And don't forget to record what is done in meetings.

More on teams and team communication can be found in chapter 7 "Managing Team Communication" in *Fundamentals of Engineering Technical Writing* .

Having Effective Meetings

The following are some tips for effective meetings:

- Plan date, time, location, who should attend
- Choose Meeting Facilitator; it can be the same person who is in charge of the project or you can choose a different facilitator each meeting
- Set an Agenda; this is done by the meeting facilitator who also asks for agenda items from the team
- Start and End Meetings Promptly (Be on time!); be courteous of other people's time
- Address Each Agenda Item Separately;
- Be Courteous and Encourage Participation
- Reach Consensus and Move On; if you cannot reach consensus or a single agenda item is taking too much time you can postpone that item to another time
- Record Decisions
    - What actions will be taken
    - Who is responsible for those actions
    - When should it be completed by

Here are two excellent Ted Talks on teamwork:

- Tom Wujec: Build a tower, build a team 7 min
- Margaret Heffernan: Forget the pecking order at work 15 min

Here are some others you may also wish to view:

- Simon Sinek: How great leaders inspire action 18 (why,

how, and what)

- Dan Pink (2009): The puzzle of motivation 18 min
- Susan Cain: The power of introverts 19 min
- Sugata Mitra: The child-driven education 17 min

More on teams and team communication can be found in chapter 7 "Managing Team Communication" in *Fundamentals of Engineering Technical Writing* .

Project Calendar

The project calendar includes not only the final date that the project must be completed by, but also a detailed list of the steps and outcomes and their due dates needed to complete the project.

For example you are writing a report. You would need due dates for all of the steps of writing, planning, research, organizing, drafting, revising, and proofreading in addition to the due date for the report.

When you plan a project calendar there are two tips that make the project itself go smoother: 1) be as detailed as possible with the project calendar and 2) use *backward planning*. Backward planning simply means you start with the due date for the project and then work backwards through the calendar from that date ensuring that you have enough time to complete each of the steps that are needed to finish the project.

To return to the report example. If it is due March 2nd, then you would plan to work proofreading from Feb. 28 through Mar 2. You would spend from Feb. 18 to Feb. 28 revising, Feb. 14 through 17th drafting, Feb 13th organizing, Feb. 7th to Feb. 12 researching and you received the assignment on Feb. 6th and spent that night planning. This is just an example but you can see how backwards planning works.

For complex projects you may want to use a Gantt chart or project management software such as Asana, Microsoft Project, Clarizen, Wrike, DaPulse, and a host of others.

Work Plan

The final step in project planning is writing out a work plan. A work plan is a summary of how you will complete the project and contains a list of personell working on the project and other necessary information. Here are some items that can be included in a work plan.

- Description of how the project will be completed.
- Identify mission and objectives.
- Create step-by-step plan showing separate tasks and activities, the outcomes that lead to deliverables.
    - Estimate effort and duration of each task
- Determine each person's responsibilities in team.
- Establish a project calendar—sequence and timing of activities.
- Estimate a project budget.
    - Money
    - Time
    - Other resources
- Summarize the deliverables (results) of the project.

Often the work plan is written as a proposal either attached to a memo (inside the company) or with a cover letter (outside the company). In this case the memo or cover letter will give a brief overview of the project, why it is necessary, etc. It would also include the completion date and contact information of the person to be contacted about the project.

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