CHAPTER

Writing and Publishing a Research Paper

8

In Chapter 4 I noted that publication is the final step in research (see section 4.1.1). It is fitting, then, to make our final step a chapter on writing and publishing a research paper.

Most HCI research papers present a novel interface idea, then describe an evaluation of the idea in a user study. User studies are designed (or should be designed!) according to accepted standards for experiments with human participants, as laid out in Chapter 5. Adhering to accepted standards is important in HCI and other fields since the practice brings consistency to the body of work that contributes to and defines the field. This practice extends to the final step in research—preparing and publishing the results.

8.1 Conference papers, journal papers

The main venues for publishing HCI research papers are conference proceedings or journals. Journals are considered the top tier for research publications. There are two primary reasons. First, journal submissions undergo a tightly controlled peer review to ensure the research is novel, correct, and carried out according to accepted standards in the field. The reviewers are experts in the subject matter and are enlisted by the journal's editor or by a member of the editorial board. Second, journals are archived in major libraries around the world; thus, research published in a journal is readily available to other researchers. For some disciplines such as physics, journal publications are virtually all that matter, with conference contributions viewed as little more than a summary of one's presentation at a meeting, the content of which appears (or will appear) in a journal publication. So the review of submissions to physics conferences is cursory, at best.

HCI is different. HCI conferences bring together researchers and practitioners, as noted in Chapter 1. The practitioners are the engineers and designers of products, and they are there to learn about the latest research in HCI. Life cycles and timelines for such products are short. The big players, like Apple, Microsoft, and Nokia, announce new products regularly and with great fanfare. So reaching and influencing the designers and engineers of products requires HCI research to have a short

Human-Computer Interaction.

timeline.[1] Unfortunately, the timeline from submission to publication in a journal is long—typically one to two years, sometimes more. For conferences the timeline is short—typically eight months, sometimes less. It is no surprise, then, that conferences and conference publications have emerged as an important vehicle for presenting and publishing research in HCI. Simply put, publishing in a conference proceedings is the quickest way to get one's work "out there." Furthermore, the archival advantage for journals no longer exists. Today, the term *archive* extends to online databases maintained by organizations such as the ACM or IEEE. The review process is also different. For some HCI conferences, the peer review process is as rigorous as it is with many journals. So the prestige of publishing in some HCI conferences, such as the ACM's annual SIGCHI conference, equals that of publishing in some journals.

Prior to publication, a research paper is a *manuscript*. In most cases, the venue for submitting is decided before writing begins. The decision will depend on many factors such as the subject matter, the timing and scope of the research, and the prestige of the conference or journal. Additional factors for considering a conference are location and travel costs, since acceptance of the manuscript implies attending the conference to present the research in a talk.

Journals generally have relaxed requirements for the format of submissions. This is reasonable since a journal submission, if accepted, undergoes a round or two of revision before publication. Revisions are introduced to improve the manuscript based on the referees' suggestions. Acceptance is often conditional on final approval by the journal editor or referees. Publication in a journal also includes professional copyediting by the journal staff. Hence, the formatting of the initial manuscript is not so important.

Conferences, on the other hand, have strict requirements on the format of submissions, including page length. There are a few reasons. For one, the timeline is short. The entire process is deadline-driven, with dates that are set for the initial submission, reviewer feedback, notification (accept or reject), and final submission. The initial submission must be formatted as per the conference requirements (see below), since there is very little time to rework a rough manuscript into the final camera-ready copy that is published.

Another reason for formatting the initial submission is that the responsibility lies with the author(s) to provide the final camera-ready copy that is published. Acceptance usually includes a request for "minor revisions," again, based on referees' suggestions. However, there is little or no vetting of the revisions or of the formatting within the manuscript, in part due to the short timelines. So formatting lies with the author and precedes the initial submission.

Before delving into formatting and presentation, let's examine the major parts of a research paper. The discussion that follows applies to conference or journal submissions that describe a user study.

[1] On timelines, see Research versus Engineering versus Design (section 4.1.4 in Chapter 4) for a contrary view.

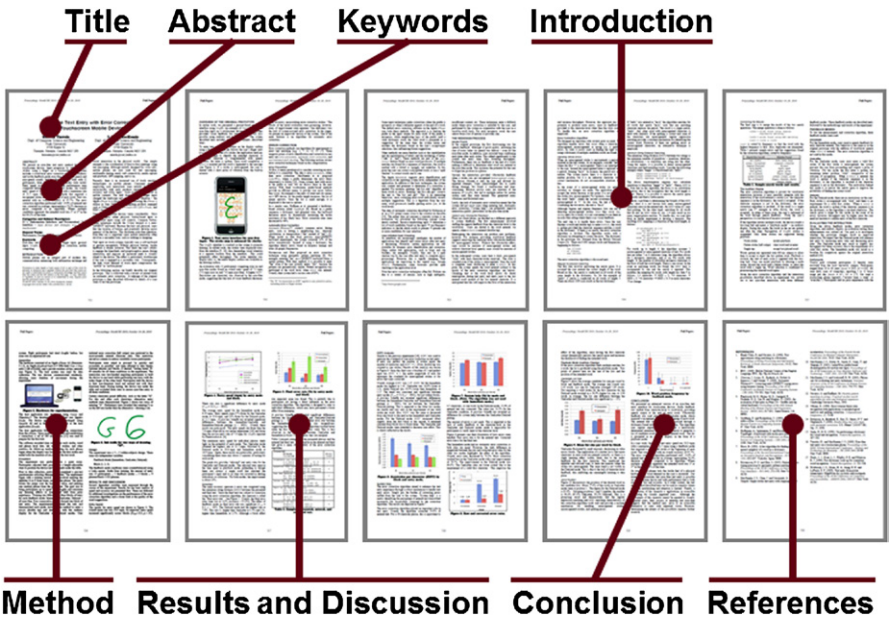


FIGURE 8.1

Parts of a research paper. The backdrop paper is a 10-page conference contribution by Tinwala and MacKenzie (2010).

8.2 Parts of a research paper

In this section, I decompose a research paper into its constituent parts. For each part, we will examine the objectives and requirements. Figure 8.1 shows the major sections using a 10-page conference paper by Tinwala and MacKenzie (2010) as a backdrop. The text is seen in two columns, as is typical for conference papers. However, this is irrelevant from the perspective of the major sections and the content.

The sections in Figure 8.1 apply to the majority of, but not all, research papers in HCI. The backdrop paper describes a novel interface idea, which was evaluated in a user study. The user study is elaborated in the "Method" and "Results and Discussion" sections. Some HCI research papers do not describe a user study. The annual ACM SIGCHI conference, for example, welcomes other types of submissions, such as "Theory," "Argument," or "Systems, Tools, Architectures and Infrastructure."[2] Although in the minority, such contributions are important to HCI. And it is likely they do not include a user study (although they could). It is worth reiterating the important role of non-experimental research in HCI. However, our discussion here focuses on a traditional HCI research paper with a user study. Let's proceed.

[2]These contribution types were noted in the *CHI 2012* submissions web site (http://chi2012.acm.org/cfp-contribution-types.shtml).

8.2.1 Title

Every word tells! A title is short, so every word must contribute. The title must identify the subject area of the paper while at the same time narrowing the scope of the work. The backdrop paper in Figure 8.1 is titled "Eyes-free Text Entry With Error Correction on Touchscreen Mobile Devices." "Eyes-free Text Entry" identifies the subject area, but alone, this is too broad. Adding "With Error Correction" limits the scope of the work. Adding "on Touchscreen Mobiles Devices" further limits the scope. Some discretion is at work here. An overly broad title fails to indicate if the paper is relevant to a sub-topic within a subject area (e.g., error correction techniques as applied to text entry). Furthermore, an overly broad title is misleading. Using only "Eyes-free Text Entry" as the title implies that the work addresses a wider area of research than it actually does.

Titles are often in two parts with a separator (typically a colon) between the main title and a secondary title. There are no rules here. Either part can serve to broaden or narrow the scope of the work. Often the goal is to catch the attention of the reader, perhaps with a provocative claim or phrase; for example, "Silk From a Cow's Ear: Extracting Usable Structures From the Web" (Pirolli, Pitkow, and Rao, 1996). Another trick is to conjure up a name for a novel technique or method and then position the name in the title; for example, "Twitinfo: Aggregating and Visualizing Microblogs for Event Exploration" (Marcus et al., 2011). Combining Twit (for *Twitter*) and info (for information) into Twitinfo has the added benefit of creating a new keyword for future searches. If the aforementioned Twitinfo is adopted in subsequent research, the source is easily retrieved via a search engine using Twitinfo as a search keyword. In short, any title is fine provided it is concise, identifies the subject area, and narrows the scope of the work.

The title is followed by the names of, affiliations with, and contact information for the authors. This information is provided and positioned according to the submission requirements of the conference or journal.

8.2.2 Abstract

The abstract is written last. There is typically a size limit imposed, such as 150 words, so the abstract must be concise. No room to expound! The abstract is a single paragraph and should not include any citations. After the title, the abstract is likely the first part of the research paper that is read. The title has caught someone's interest; the abstract then delivers a succinct summary of the story within. After reading the abstract, the reader will decide if the rest of the paper is relevant and worth reading.

If the abstract is poorly written and fails to deliver on its essential objective (see next paragraph), then the paper has little chance of being read, or even worse, being accepted for publication. So edit, edit, edit. The abstract should be the best-written section of the paper. The English and grammar should be perfect, the content succinct and clear. A poorly written abstract foretells of a tough slog ahead for anyone with the patience to continue reading.

The objective of an abstract is two-fold. The abstract should tell the reader *what was done* and *what was found*. Both themes are highly condensed since the abstract is constrained in size. Nevertheless, this is the abstract's mission. An example of a well-crafted abstract is provided by Sandnes (2006, 245) in a paper titled "Can Spatial Mnemonics Accelerate the Learning of Text Input Chords?":

> *This study addresses to what extent spatial mnemonics can be used to assist users to memorise or infer a set of text input chords. Users mentally visualise the appearance of each character as a 3x3 pixel grid. This grid is input as a sequence of three chords using one, two or three fingers to construct each chord. Experiments show that users are able to use the strategy after a few minutes of instruction, and that some subjects enter text without help after three hours of practice. Further, the experiments show that text can be input at a mean rate of 5.9 words per minute (9.9 words per minute for the fastest subject) after 3 hours of practice. On the downside, the approach suffers from a relatively high error rate of about 10% as subjects often resort to trial and error when recalling character patterns.*

The first three sentences convey the topic of the research and what was done. The last three sentences convey what was found. The abstract is short (144 words). It fulfills its mandate, no more, no less. Note that there is no introductory material. Indeed, an abstract is not the place to introduce the subject matter of the paper. Unfortunately, treating the abstract as an introduction is a common flaw. This point deserves emphasis: *The abstract is not an introduction to the subject matter of the paper*. The reader has read the title and is now examining the abstract for further details. It is reasonable to assume, therefore, that the reader is familiar with the subject matter. Save the introductory material for the Introduction. Another common flaw in abstracts is the failure to give specific results. All too often, abstracts convey general conclusions and note that detailed results and discussions are found in the paper. Not good. Convey the most salient finding(s) in the abstract.

8.2.3 Keywords

Keywords are used for database indexing and searching. They allow others who are interested in the work to find it. Keywords are chosen by the author. They identify the subject matter and the scope of the work. For the backdrop paper in Figure 8.1, the keywords are "Eyes-free, text entry, touchscreen, finger input, gestural input, Graffiti, auditory display, error correction, mobile computing."

Since 1998, research papers published in ACM conference proceedings or journals are required to also include indexing and retrieval information according to the ACM's Computing Classification System (CCS). As the ACM notes, "This is beneficial to you because accurate categorization provides the reader with quick content reference, facilitating the search for related literature, as well as searches for your work in ACM's Digital Library and other online resources."[3] In applying the CCS,

[3] www.acm.org/about/class/how-to-use.

Categories and Subject Descriptors
H.5.2 [Information Interfaces and Presentation]: *User Interfaces – input devices and strategies (e.g., mouse, touchscreen)*
General Terms
Performance, Design, Experimentation, Human Factors

FIGURE 8.2

Example of the ACM Computing Classification System.

research papers include "Categories and Subject Descriptors" and "General Terms." (For conference submissions, the general terms are optional.) The descriptors and terms are provided by the ACM, not the author. Since the CCS spans all of computer science, the choices are numerous. The descriptors and terms for the backdrop paper in Figure 8.1 are shown in Figure 8.2. The terms are taken from the ACM's CCS, which is available online (see URL in footnote). The formatting shown in the figure (e.g., brackets, bold, italics) is required and must be strictly followed. Although choosing descriptors and terms is a challenge, there is an easy way. Just find a paper on the same or similar topic in the same proceedings or journal as the paper in preparation and mimic that paper's descriptors and terms. In fact, the ACM recommends this (see URL in footnote). Of course, care is warranted in the event of an inappropriate descriptor in a published paper.

8.2.4 Introduction

The opening section of a research paper is typically called *Introduction*, although other labels, such as *Background*, are fine as well. The introduction gives the context for the research. Usually opening comments characterize the state of the art and indicate why the subject matter is interesting and relevant. A user interface problem or challenge is identified and the reader is alerted, early on, to the solution that is developed in the rest of the paper. It is common practice to give an overview of the contents of the entire paper, usually at a convenient place within the first page or so of the introduction. Figure 8.3 is an example from the backdrop paper (Figure 8.1). The excerpt appears as the fifth paragraph in the introduction.

It is also desirable to state the contribution of the work. This is tricky, since it entails laying down the bragging rights, so to speak, for a novel aspect of the work. A statement like, "The approach presented here is the first example of . . ." is strong but in most cases should be avoided. Usually it is sufficient to note that the idea improves on existing practice, or something similar.

The introduction may span several sections. Any reasonable organization is fine. Other sections may use the same level of heading as the introductory section, and subsections may be added as appropriate. It's your story to tell! Take liberties to prepare and organize the introduction as you see fit.

Usually a literature review is expected. This is typically organized in a separate section, with an appropriate heading (e.g., *Related Work*). The literature review discusses earlier published work related to the subject matter of the research. Points

In the following section, we briefly describe our original prototype. This is followed with a review of related work on automatic error correction. A redesign of the original prototype is then described followed by details of a user study to test the prototype.

FIGURE 8.3

Provide an overview of the entire paper early in the Introduction.

relevant to the current research are presented. A citation is included for each publication mentioned. Include figures, charts, or tables as appropriate.

The main ideas developed in the paper should be laid out in detail. Use formulas, screen snaps, sketches, or any appropriate visual aid to help the reader understand the solution to a problem that the research presents. The introduction usually finishes with a statement indicating the need to test the idea in an empirical evaluation. This sets the stage for the method section.

8.2.5 Method

The method section of a research paper tells the reader how the experiment was designed and carried out. Although the heading *Method* or *Methodology* is most common, this section is sometimes given other titles, such as *Evaluation*, *Experiment*, *User Study*, etc.

The method section should be written in an entirely straightforward fashion. Any creative flair conveyed in the introduction should come to a full stop here. The method section should read like a recipe. The reader wants to know what you did and how you did it. This information must be delivered in a style that is simple, clear, and predictable.

I noted earlier that a critical requirement of research is that it must be reproducible (see section 4.1.3). The method section delivers this crucial property. After reading the method section a reader might ask, "Could this research be reproduced?" If the reader is reviewing the manuscript for a conference or journal and answer is "no" or "I'm not sure," there is little chance of acceptance.

Predictability is important. It allows a reader to scour papers and quickly find key points and results. A reader will lose patience if it is a struggle to determine the independent and dependent variables, the number of participants, the tasks performed by participants, and other important details of the experiment. So keep it simple, make it predictable. On predictability, convention dictates that the method section is divided into the following subsections (and in the following order):

- Participants
- Apparatus
- Procedure
- Design

Let's examine each of these.

8.2.5.1 Participants

The participants section states the number of participants and how they were selected. Relevant demographic information is also given, such as age, gender, and related experience. Other details might be useful, such as level of education, first language, handedness, or whether the participants wore eye glasses or corrective lenses. The details to provide depend on the task and apparatus used in the experiment.

The information on participants identifies the *population* of people used and, therefore, the population to which the results apply. It is reasonable to limit the population pool to people with certain skills or attributes, if it makes sense for the research. An experiment on gaming devices, for example, might only enlist college-age users who play computer games more than 10 hours per week. That's fine, but the results may not generalize to other people.

The participants section is usually short—just a couple of sentences. However, if a property of the user (cf. the interface) is an independent variable, then the participants section is often more detailed. For example, Brajnik et al. (2011) describe an experiment where an independent variable was "expertise in judging websites for accessibility." The experiment included a group of experts and a group of non-experts. The participants section of the paper is quite detailed, as it is necessary to quantify the degree of expertise for both groups and to describe how such was determined and applied.

8.2.5.2 Apparatus

The *Apparatus* section describes the hardware and software. Other titles for this section include *Materials*, *Interface*, etc. Think of reproducibility when preparing this section. Give all the details necessary so that a skilled researcher could replicate the apparatus if he or she chooses. Of course, needless details can be excluded. Mention, perhaps, that the test computer was a Lenovo Thinkpad T60 running Microsoft Windows 7, but the amount of memory or the capacity of the hard drive is likely of no consequence. Some discretion is warranted. If the experimental task involved finger input on a touchscreen, then the make and model of the touchscreen should be given. Other details that might be relevant include the screen resolution, screen size, sampling rate, how the screen was held, or even the participants' finger sizes.

If the experiment used a custom interface, the development language (e.g., Java) and other relevant details should be given. It is particularly useful to provide screen snaps or photos of the interface. If comprehensive details of the interface were disclosed prior to the method section, then it is reasonable to simply refer the reader to the earlier material; for example, "the software included the algorithm described in the preceding section."

8.2.5.3 Procedure

The procedure section tells exactly what happened with each participant. State the instructions given, and indicate if demonstration or practice was used, etc. If

The feedback mode conditions were counterbalanced using a Latin square. Aside from training, the amount of entry was 12 participants × 3 feedback modes × 3 blocks × 4 phrases/block = 432 phrases.

FIGURE 8.4

A calculation reveals the total number of trials in the experiment.

participants completed a questionnaire before or after testing (or both), indicate this in the procedure section. It is also common to indicate if participants were paid, volunteered without pay, or were required to participate, for example, as part of a university course.

Typically, participants are tested over multiple conditions and perhaps multiple trials for each condition. Give the details. Usually there is a specific task that participants performed. Ensure the task is properly defined. What was the task? What was the goal of the task? When did timing begin and end? Were errors recorded? Give a precise definition of what constituted an error. Were participants allowed and instructed to correct errors? Did they correct all errors or only at their discretion? How were errors corrected? Were rest breaks allowed or encouraged? What was the total time for testing with each participant? And so on. Again, a screen snap of the interface may help. It is also useful to include a photograph of a participant performing the task.

8.2.5.4 Design

The design section summarizes the experiment in terms of the independent variables (factors and levels), the dependent variables (measures and units), or other relevant details. For short papers, these details are sometimes given in the procedure section. It is common to begin with a statement such as, "The experiment was a 3 × 2 within-subjects design." If counterbalancing was used, the way the conditions were administered to participants should be stated. Be thorough and clear! It's important that your research is reproducible.

A good way to conclude the design section is to indicate the total number of trials administered in the experiment. This can be revealed by a calculation that includes the number of participants and the variables and repetitions in the study. Figure 8.4 shows how this was done in the backdrop paper (Figure 8.1), which used a text entry task with feedback mode (three levels) as the main independent variable.

8.2.6 Results and discussion

Following the method section, the results of the experiment are given. It is common in HCI to combine the results with discussion. (Sometimes a discussion section follows the results section.) Note also that the heading *Results and Discussion* is at the same level as *Method*. (Results are not part of the method.)

> The mean task completion time for method A was 2.7 seconds. Method B was 9.1% slower with a mean task completion time of 3.0 seconds.

FIGURE 8.5

Reporting results in absolute and relative terms.

If there were outliers or problems in the data collection, state this up front and give details on any filtering of the data that took place before analysis. Before presenting the results it is common to describe the statistical approach and tests used in the data analysis.

Although there are no strict rules, it is common to use subsections that organize the results by dependent measures, beginning with the most important dependent variable. Often this is speed or task completion time. Then results are presented for accuracy or error rate, followed by results for other dependent variables.

For each dependent variable, begin with a broad observation, such as the overall mean, and then move to finer details such as the means for each test condition. The difference in the means between test conditions is the effect size. In HCI, effect size is typically given either as an absolute difference or as a relative difference, expressing the percent difference between one condition and another. Providing the means as absolute values and the difference as a percent is useful since the practical implications of results can be assessed. For example, if the mean task completion time was 3.0 seconds for Method A and 2.7 seconds for Method B, then the result can be presented as in Figure 8.5.

It is important to explain the results through discussion: What caused the differences in the measurements across experimental conditions? What detail in the interaction caused one method to be slower? Did one condition require more input actions? Were participants confused? Was the method hard to learn? Did participants experience fatigue or discomfort? Were corrective actions required as the task was carried out? Obviously the answers lie in the interactions used in the experiment and the observations made by the experimenter or obtained through a post-experiment questionnaire or interview.

There is very likely a difference in the observed dependent measures across experimental conditions. The difference may be real or it may be an artifact of the variability that occurs in experiments with human participants. Of course, finding a real difference is often the goal of the research: a novel interaction method improves on an existing interaction method. “Improves on” usually implies interaction that is faster, more accurate, more efficient, or better in some other quantifiable manner (e.g., fewer re-tries, less movement, higher quality results, etc.). Testing for a real difference typically involves doing an analysis of variance on the data, as described in Chapter 6. The results of this test are given in a succinct statement indicating the outcome. See Figure 6.5 for an example where the difference is real (i.e., statistically significant). See Figure 6.8 for an example where the difference is deemed a

random effect (i.e., not statistically significant). In conveying the ANOVA results, bear in mind that the statistical tests are not the results per se. The results lie in the observations and measurements. So avoid characterizing the results in terms of statistics. Of course, finding a statistically significant effect of an independent variable on a dependent variable is important. But the statistical test is simply the supporting evidence. The result is the difference in outcome between the test conditions.

Experimental software is often designed to log a considerable amount of data. Sifting through the data is a daunting task; however, do not feel compelled to share all the data with the reader. Giving too many results or too much data is an indication that you can't distinguish what is important from what is unimportant. A key challenge, then, is deciding on which results to present and which not to present. Furthermore, there is generally no value added in giving results just "for the record." If there is no insight to be gleaned from a result, then don't include it.

Another way to make results interesting for the reader is through visuals. Bar charts, line graphs, 3D plots, or the like appear in most research papers in HCI, with examples appearing throughout this book.

The results and discussion section should compare the results with those in other research papers on a similar topic, citing prior work as appropriate. Is the new technique faster, slower, more accurate, less accurate?

The results and discussion section also summarizes information obtained through questionnaires or interviews given at the end of testing. Participant feedback is often enlightening. Include it. Discuss it. What does participant feedback suggest in terms of improvements to the interaction?

8.2.7 Conclusion

The conclusion summarizes what you did, restates the important findings, and restates the contribution. It is common to identify topics for future work, although developing new ideas is to be avoided in the concluding section.

The conclusion is often followed by an acknowledgment thanking funding sources as well as people who assisted in some way with the research.

8.2.8 References

The last section of a research paper is the reference list. The list contains the full bibliographic details on papers cited earlier in the paper. Only papers cited in the paper are included in the reference list. References should be formatted as stipulated by the conference or journal. Formatting details are discussed in the next section.

8.3 Preparing the manuscript

The experience in reading a research paper should be like the experience in listening to music. Hopefully the music is creative, interesting, and well executed.

Hopefully, as well, the listening experience is free of non-musical artifacts in the playback system or environment, such as static, noise, distractions, or other sounds. Music that is creative and well executed might fail to engage the listener due to these extraneous factors.

Similarly, a research paper seeks to present ideas that are creative and interesting. And the research must be well executed, in accordance with expected standards in the field and as described throughout this book. But there is more. Research that is creative and well executed might fail to engage the reader due to factors aside from the quality of the research. If the reader is distracted due to flaws in the delivery and presentation, he or she may have difficulty following and understanding the ideas. Soon enough, the reader's patience wears thin. So presenting ideas that are creative and well executed is not enough. The story must be properly assembled and presented.

In this section, I present ideas and suggestions on preparing a manuscript. The process is more about transparency than flair: writing in a straightforward style and constructing figures, tables, and other visuals that are simple, clear, and consistent. Easier said than done. But resist any temptation to jazz up the presentation. A research paper is a product of scholarship, not a marketing brochure.

8.3.1 Formatting

Formatting is about the minutia: the punctuation, spelling, capitalization, italics, quotations, abbreviations, numbers, variables, and so on. These properties of a manuscript are important for clarity and flow. The goal is to get the formatting right; actually, perfect. In fact, get it so perfect that the reader won't even notice. Remember, one of the first persons to read the paper will be a reviewer, who will make a recommendation for accepting or rejecting the paper. Will the reviewer critique the paper based on its value and novelty and put aside a confusing presentation or poor formatting that causes him or her to read, then re-read? Perhaps, but this is a chance you don't want to take. It is distinctly possible that a reviewer who struggles with formatting flaws and other distractions will eventually lose patience and render a negative opinion. The goal is to let the story of the research come through.

Formatting rules are too numerous to set out here. Fortunately, there are numerous references to assist. *The Publication Manual of the American Psychological Association* (APA) is recommended (APA, 2010). Chapter 4 in the latest edition (the 6th) is The Mechanics of Style. It contains a wealth of tips, actually *rules*, for formatting manuscripts. There are subsections on small details—proper use of the period, comma, semicolon, colon, double or single quotation marks, parentheses, brackets, slash—and subsections on broader details like capitalization, hyphenation, italics, abbreviations, statistics, and spelling. The APA also has a style website (www.apastyle.org) that is searchable on any topic of interest, including formatting rules.

Of course, a dictionary is also a valuable asset. Reputable dictionaries such as *Merriam-Webster's Collegiate Dictionary* or the *Oxford English Dictionary* are considered the final authority on spelling.[4] For some words there are differences in

the American and British spellings (*labor* versus *labour*). Either form is generally accepted provided the choices are applied consistently throughout a manuscript. Dictionaries teach in other ways. A dictionary is a good source to determine if a word is capitalized (*Internet*), hyphenated (*e-mail*), not hyphenated (*online*), set as two words (*screen snap*), or set as a single word (*database*).

To facilitate formatting, conferences provide template files, typically in both Microsoft Word and LaTeX formats. The template embeds many of the formatting requirements such as the margin sizes, fonts for headings and text, line spacing, paragraph spacing, and so on. Generally, the manuscript is prepared directly in a renamed copy of the template file.

The template file also provides instructions and guidance on aspects of the paper under control of the author. These include writing style, the preparation of figures and other visual aids, formatting for citations and references, etc.

8.3.2 Citations and references

Citations and references are the connections that tie research together. Research submissions (e.g., for CHI) have formatting requirements for citations and reference lists. This is one area where HCI conferences generally deviate from the APA guidelines. The following is a quick view into the formatting of citations and references for conference submissions to CHI and many other HCI conferences.

8.3.2.1 Reference list

Figure 8.6 illustrates the formatting for five common types of publications in reference lists in HCI conference proceedings: a conference paper, a journal paper, a book, a chapter in an edited book, and an Internet document.

Citing web pages or documents downloaded from the Internet as the primary source for research is discouraged. However, if a relevant source is only available on the web or as a downloadable document, then it is reasonable to cite it. Unfortunately, there are not yet standardized rules for citing and referencing these sources. The example in Figure 8.6 includes four items: the source (e.g., author or organization), the title (set in italics), the URL, and the date the document was accessed.

The following is a checklist of common formatting rules for reference lists in conference publications:

- References are numbered.
- References are ordered alphabetically by first author's surname.
- For each author, the surname comes first, followed a comma, then the initials for the given names. Include a space between the initials if there is more than one (e.g., "Smith, B. A." not "Smith, B.A.").
- For the title of the publication, only capitalize the first word, the first word in a secondary title (e.g., after a colon), and proper nouns.

[4]Online versions are at www.merriam-webster.com/dictionary and http://oxforddictionaries.com.

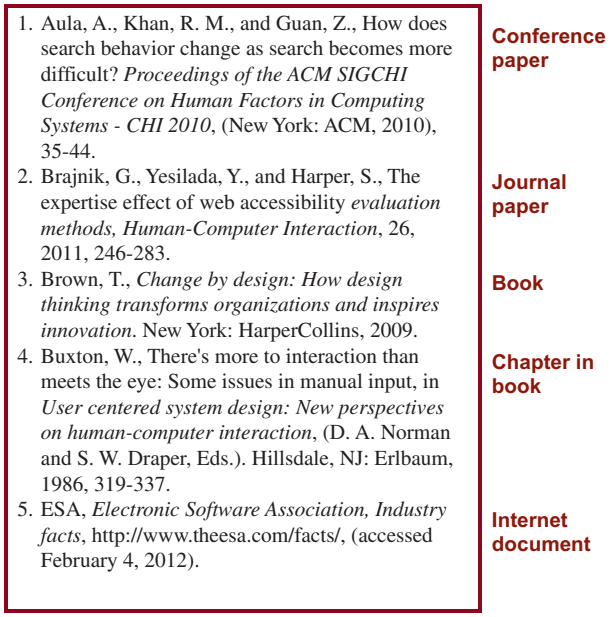


FIGURE 8.6

Formatting examples for common types of publications in a reference list in a conference proceedings.

- Always include the year. Substitute "in press" for accepted but not-yet-published papers.
- Always include page numbers (except for complete books or web pages).
- The name of the publication is set in italics with all keywords capitalized (e.g., *Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems—CHI 2011*).
- For journal publications, include the volume number in italics.
- If space permits, use the full name for conferences and journals. If space is tight, use abbreviated names for conferences and journals (e.g., *Proc CHI '99*). Do not mix full and abbreviated names; use one style or the other. If using abbreviated names, be consistent.
- Give the location and name of the publisher for conference papers and books (e.g., "New York: ACM"). Use the most economical yet understandable expression of the location (e.g., "New York," not "New York: NY"; but use "Cambridge: MA") and publisher (e.g., "Springer" not "Springer Publishing Company").
- Use *align left* (ragged right) for the reference list. (Note: The rest of the manuscript is justified.)
- Only include works that are cited in papers.
- Study and imitate!
- Be consistent.

8.3.2.2 Citations

Citations connect current research with prior research or other sources. Most commonly for conference submissions, citations appear as numbers in brackets. The following are examples and tips for correctly citing prior work.

A basic citation:

> A previous experiment [5] confirmed that…

Group multiple citations together. Separate the numbers with a comma followed by a space. Preface the list with "e.g.," but only if there are additional known sources supporting the same point:

> Our results are consistent with previous findings [e.g., 5, 7, 12].

Do not treat citations as nouns:

> It was proposed in [5] that… *** Incorrect ***
> It was proposed by Smith and Jones [5] that… *** Correct ***

There is an exception to this rule. When it is inside parentheses, a citation may serve as a noun:

> There are many user studies on this topic (see [6] for a review).

Quotations require a citation with a page number:

> Smith and Jones argue, "the primary purpose of research is publication" [14, p. 125].

If citing a specific point from a book, include the page number. If the point spans several pages, indicate the range, as shown here:

> Norman defines six categories of slips [15, pp. 105-110].

If a paper is referred to by author(s), cite the first author followed by "et al." (Latin for "and others") if there are three or more authors:

> Douglas et al. [5] describe an empirical evaluation using an isometric joystick.

Alternatively, include all the authors' names for the first appearance of the citation and use "et al." for subsequent appearances. Of course, all the authors' names appear in the reference list.

It is worth the effort to get the citations and references correct. Thompson Reuters' *EndNote* (www.endnote.com) is a tool that greatly simplifies that task. It works with a bibliographic database and a plug-in for word processors such as Microsoft Word. With EndNote, inserting a citation is as simple as copy (from the database) and paste (at the desired location in the manuscript). Formatting the bibliography is typically done by an option in the Tools menu or EndNote ribbon. The process formats both the citations within the manuscript and the references list at the end. Numerous styles are included with EndNote and they are easy to customize according to the submission requirements of a conference or journal.

8.3.3 Visual aids

Visual aids are powerful tools for conveying ideas and results. Few areas in experimental research have gained more from technological advances than the methods and tools for displaying results. Charts, tables, graphs, drawings, and photographs are now fully in the digital domain, with sophisticated tools for editing and stylizing the presentation.[5]

One of the most common results to present is the effect of an independent variable on a dependent variable. A bar chart is usually the most appropriate format, since most independent variables are nominal-scale attributes. An example is shown in Figure 8.7a. The chart shows the results of Zhu et al.'s experiment on teleoperation (Zhu, Gedeon, and Taylor, 2011). Participants used a scene camera while manipulating a robot arm to nudge rocks into a hole. The independent variable was camera control model (manual, natural, auto). The dependent variable was the number of rocks sunk in a specified time interval. As seen in the figure, the natural model performed best. (This was confirmed in an analysis of variance.) Note the presence of error bars. Error bars are an important reminder to the reader of variability in human responses. However, error bars add little insight unless they are appropriately labeled, for example, in the figure's caption (which was not the case in Zhu et al.'s paper).

If the variable shown along the x-axis is continuous, then a line chart is appropriate. In Zhu et al.'s experiment on teleoperation, participants proceeded under a time constraint. An additional result was provided on the number of rocks sunk in each of three 60-second intervals. (See Figure 8.7b.) The lines between intervals convey a sense of continuity as the experiment trials progressed.

Well before the Results and Discussion section, visuals are an important adjunct to text. Visuals can clarify concepts about the research or the technical details of an apparatus. In preparing a manuscript, try to find opportunities to assist the reader wherever possible. The methodology in particular can benefit from a judicious and targeted use of visuals. A powerful way to augment the procedure section of a research paper is through a photograph of a participant performing the experiment

[5] Of course, hand drawn sketches maintain a special appeal (see Figure 3.46 or Figure 7.5).

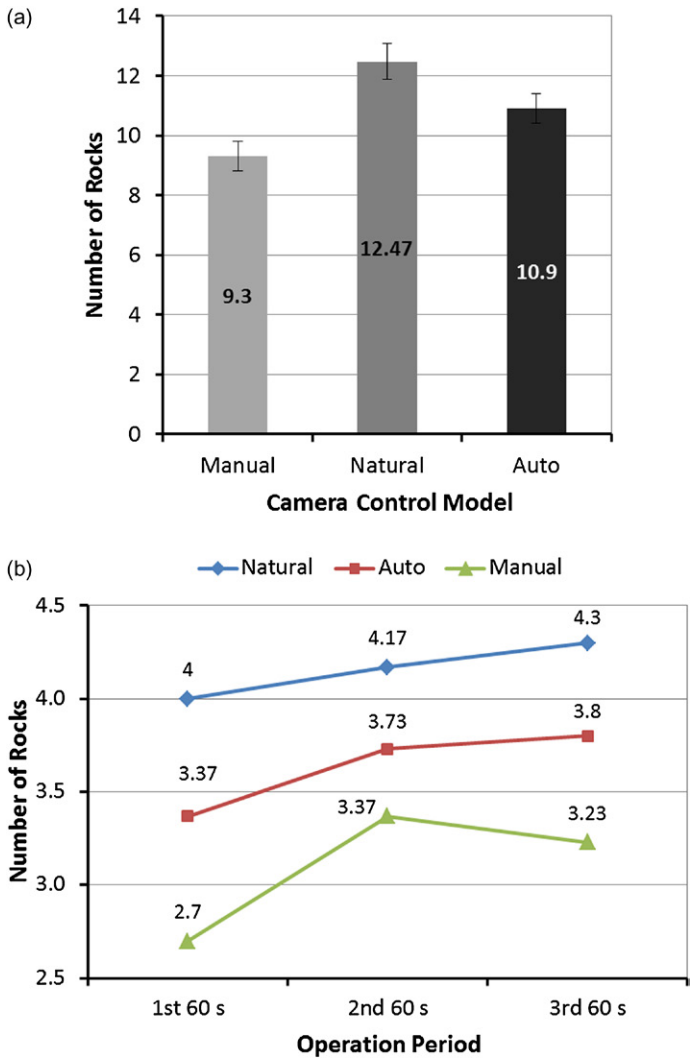


FIGURE 8.7

Charts presenting results: (a) Bar chart for categorical data. (b) Line chart for continuous data.

(Adapted from Zhu et al., 2011)

task. Two examples are shown in Figure 8.8. Part (a) shows a participant performing an eyes-free task with auditory feedback (Tinwala and MacKenzie, 2008). Part (b) is an experiment that involves Lego construction and identification (Ranjan, Birnholtz, and Balakrishnan, 2007). The photos help a reader understand the nuisances of the experiment task.

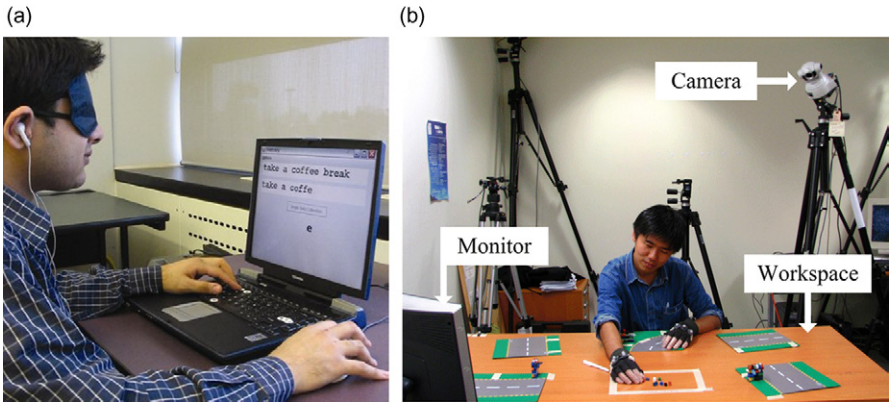


FIGURE 8.8

Photographs of experimental tasks: (a) Eyes-free input with auditory feedback (Tinwala and MacKenzie, 2008). (b) Lego construction and identification (Ranjan et al., 2007).

(Photo courtesy of Abhishek Ranjan)

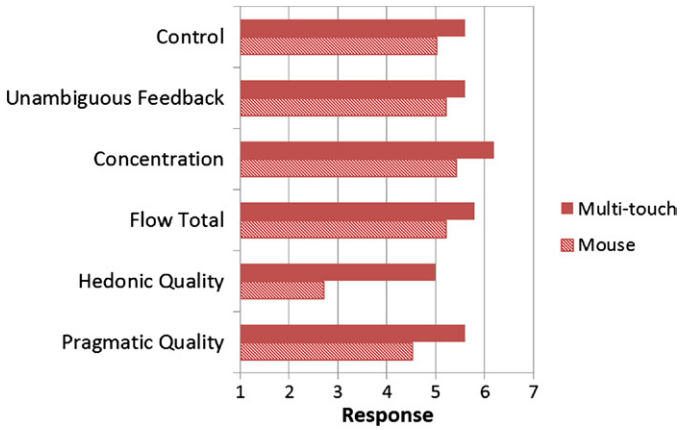


FIGURE 8.9

A chart summarizing participant responses from a questionnaire on target acquisition using multi-touch versus a mouse.

(Adapted from Leftheriotis and Chorianopoulos, 2011)

Summaries of Likert-scale questionnaire items may be presented as shown in Figure 8.9 (Leftheriotis and Chorianopoulos, 2011). The chart shows participants' impressions in a target acquisition task using multi-touch and a mouse. Seven is the most favorable response. Clearly participants preferred multi-touch, as this condition was rated higher on all items. The difference was particularly pronounced in the item about hedonic quality (pleasure) with scores of 5.1 for multi-touch

compared to 2.8 for the mouse. A visual presentation, as here, helps the reader understand the results both in absolute and relative terms.

8.3.4 Writing for clarity

The goal in writing a research paper is communication. Effective communication demands clarity: "a clear mind attacking a clearly stated problem and producing clearly stated conclusions" (Day and Gastel, 2006, pp. 3–4). Clarity comes with economy—saying what needs to be said and little else. This theme appears in the ACM SIGCHI's template for research papers.[6] The template includes a section called "Language, Style, and Content," with recommendations organized in a bulleted list. The list begins:

- Write in a straightforward style.
- Avoid long or complex sentence structures.

So the goal in writing a research paper is to organize and deliver the story of the research in sentences that are simple and straightforward. This seems simple and straightforward. But it isn't. Writing with clarity and economy is a challenge that is never fully achieved. Even the most seasoned researcher continuously struggles to express ideas in the clearest and most succinct way possible. The guard must never be down, lest the prose enlarge and swell.

Writing with clarity is both a craft and an art. The craft is driven by rules, rigor, and precision. The art is creative, engaging human qualities such as imagination, inspiration, ingenuity, and originality. Succeeding at both, and with a balance that retains economy while delivering style, is a challenge. However, unlike fictional writing, the balance for scholarly writing leans toward craft. In scholarly writing, clarity trumps all.

It is outside the scope of this book to teach either the craft or art of scholarly writing. The topics include sentence structure, grammar, tense, flow, tone, continuity, economy of expression, and so on. It is a huge assignment. Besides, excellent sources on these and related themes already exist. Four sources are recommended below. The first three address scholarly writing as well as the methodology in experimental research. The fourth is the classic "Strunk and White," first published in 1919. At 105 pages, it packs more punch per page than any other source on writing style. It is not to be passed over.

1. The APA's *Publication Manual of the American Psychological Association* (APA, 2010)
2. Day and Gastel's *How to Write and Publish a Scientific Paper* (Day and Gastel, 2006)
3. Martin's *Doing Psychology Experiments* (D. W. Martin, 2004)
4. Strunk and White's *The Elements of Style* (Strunk and White, 2000)

[6] http://chi2012.acm.org/CHI2012USpaperformat.doc.

Original	Revised
In order to do this	To do this
Should be able to understand	Should understand
The software used was our	The software was our
Stacking objects one on top of the other	Stacking objects
Prior gaming experience	Gaming experience
With this goal in mind	With this in mind
Two paths that can be taken to reach the	Two paths to the
The selection was made based on	The selection was based on
The use of the homing keys helps	Homing keys help
The top five most frequent letters	The five most frequent letters
The rate at which the cursor moves	The rate the cursor moves
The ESC key on the keyboard	The ESC key
Each of the participants	Each participant
Can be used to show	Can show
The average value can be calculated as	The average is
When they were ready	When ready
It is worth mentioning that the number of	Notably, the number of
For the sake of consistency	For consistency
The number of keys the user has to press	The number of key presses
The time it takes to compose a message	The time to compose a message
Users who prefer to use the keyboard	Users who prefer the keyboard
This is not a recommended idea	This is not recommended
Three types of interaction techniques	Three interaction techniques
Should be able to quickly adapt	Should quickly adapt
At any given time	At any time
To the best of our knowledge	To our knowledge
The movement time required to	The movement time to
For the purpose of improving text entry	For improving text entry
Because the selection operation requires	Because selection requires
Sorted in the order of their similarity	Sorted by similarity
Is done using	Uses
The time taken to complete the task	The time to complete the task
Was developed in an attempt to	Was developed to
One point to note is that	Note that
Two different methods of input are	Two methods of input are
We ran an exploratory pilot study	We ran a pilot study
At their own discretion	At their discretion
Studies conducted in the past have found	Studies have found

FIGURE 8.10

Omit needless words.

There is one strategy leading to clarity of expression that I will dwell on in the closing paragraphs. It is, in this author's view, the single most powerful technique for transforming a loosely written manuscript into a succinct and clear research paper. The technique is simple: get rid of clutter.

If clarity is the prize, clutter is the curse. A profusion of words that fills space but adds nothing is certain to suffocate any research paper. Without doubt, the reader who faces a stream of added useless words will quickly tire. The superfluous words demand the reader's attention—so as not to miss a point—but in the end they encumber rather than enlighten. Every source on writing style has a take on this subject. Strunk and White's Rule #17 is to Omit Needless Words: "A sentence should contain no unnecessary words, a paragraph no unnecessary sentences, for the same reason that a drawing should have no unnecessary lines and a machine no unnecessary parts" (Strunk and White, 2000, p. 23). The APA's *Publication Manual* is more pedantic: "You can tighten long papers by eliminating redundancy, wordiness, jargon, evasiveness, overuse of the passive voice, circumlocution, and clumsy prose" (APA, 2010, p. 67).

A sampling of edits in view of Strunk and White's Rule #17 is found in Figure 8.10. The examples are real. They are from a much larger collection compiled by this book's author over many years while editing, co-authoring, or reviewing HCI manuscripts. In each case, redundant words are removed. The revised phrase is succinct. It delivers the same point with less energy demanded of the reader.

There is little to gain in analyzing each revision in Figure 8.10. Perhaps one observation is worthwhile, however: user studies that are written about in the past tense have already been *conducted*. Furthermore, they were conducted *in the past*. See the last example in the figure. Yes, every sentence should be parsed in this manner. Break it down. Get rid of every word that fails to contribute. The result is clarity and economy—a better manuscript.

When preparing the initial draft of a manuscript, relax. First and foremost, get the words and ideas down and into the manuscript. It would be nice if the editing that produced the revisions in Figure 8.10 surfaced in the first draft. But this is not likely and it needn't be attempted. Few writers are gifted enough to produce crisp prose in the first pass. So don't struggle to make the initial draft the final draft. But before submitting the manuscript, give it every ounce of editing that time permits. The reviewers will appreciate it, and the result may ultimately—and hopefully—achieve that final and essential step in research: a publication. Congratulations and good luck.

STUDENT EXERCISES

8-1. Use Google Scholar or the ACM Digital Library to locate several research papers from a recent conference proceedings. Study the abstracts to determine if they are succinctly and clearly written and if they convey what was done and what was found in the research. Choose two of the abstracts (perhaps the best and worst) and prepare a brief report or presentation on your analysis. Suggest improvements, as appropriate.

8-2. Design and administer a questionnaire to a group of people (participants). Collect data on characteristics of the participants and aspects of their

interaction with technology. Analyze the data and write a report outlining the topic (Introduction), the methodology (Method) and the results (Results and Discussion).

Participants are drawn (ideally, at random) from a population. For this exercise, use a sample of university students or another population conveniently available, such as people at a local shopping mall or metro station or in the neighborhood where you live.

Narrow the population as appropriate. For example, if there is an interest in Apple Mac users, Twitter users, or people over the age of 50, then screen candidates and use only those from the desired population. Use at least 25 participants.

The participants may be given the questionnaire to complete. Alternatively, use an interview style and interact directly with participants. In the latter case, more reliable information is obtained since participants are more engaged and can ask for clarification.

So what data are of interest? A questionnaire usually begins by asking simple demographic information such as age and gender. Also solicit more specific information relevant to the topic, such as first language spoken, number of hours per day using a computer, hours per day playing video games, preferred browser (IE versus Firefox), preferred computer type (Mac versus PC), number of tweets sent per day, preferred texting method (multi-tap versus *T9*), estimated typing speed, and so on. There are numerous possibilities. Try to think of interesting relationships and ways to summarize, group, and graph the data.

Try to venture beyond the examples above. Remember, this is your research project! What other relationships are there? Do Faculty of Arts students differ from Faculty of Science students in . . . ? Does age or gender make a difference in . . . ? Do left-handed people prefer . . . ? Is the number of text messages sent per day related to . . . ? Are mobile phone users more likely to . . . ? Which pointing device do users of notebook computers prefer? Are people more likely to answer an incoming phone call if it is from a friend compared to a parent or co-worker? Is the latter behavior more prominent for males than females? Is there an age effect? Are Starbucks devotees more likely to use an iPod than customers at Timothy's? Are people with body piercings more likely to prefer a Mac to a PC?

Sounds like fun, right? Sure, but relationships need a plausible explanation. For example, it is unlikely people who wear glasses differ in their texting habits from people who don't wear glasses. But who knows? If a relationship such as this is investigated, that's fine, but develop a plausible reason for the difference (and include it in your report). If, in the end, the relationship sought doesn't surface, that's fine, too. But an explanation is necessary. Hint: use Google Scholar to determine if other researchers have investigated a similar topic. You may be surprised by what you find.

Think about the way information is gathered in the questionnaire. Do not ask participants their names. Instead, give each one a code (P1, P2, P3, . . .). Simple nominal-scale, or categorical, data are gathered as follows:

What is your gender? ☐ male ☐ female

If there is interest in knowing how many hours per day participants use a computer, the questionnaire could include

Please indicate your computer usage:
☐ <2 hrs/day ☐ 2-5 hrs/day
☐ 5-10 hrs/day ☐ >10 hrs/day

Gathered in this manner, the responses are tabulated as counts, or number of respondents, per category. These data are useful to show categorical relationships such as computer usage (low, medium, high, very high) versus gender (male, female). Such data are organized in a contingency table and examined with a chi-square test (see section 6.2).

The same information is available as follows:

How many hours per day do you use a computer? _____

Responses formed in this manner are examples of ratio-scale data. Provided there is a second ratio-scale characteristic, such as age, the degree of correlation (r) between the two variables can be shown. Also, a prediction equation can be built where one variable is predicted from the other (see section 7.2.1).

A 5-point Likert scale can be used with a preamble such as "Please indicate your level of agreement to the following statements." Here's an example:

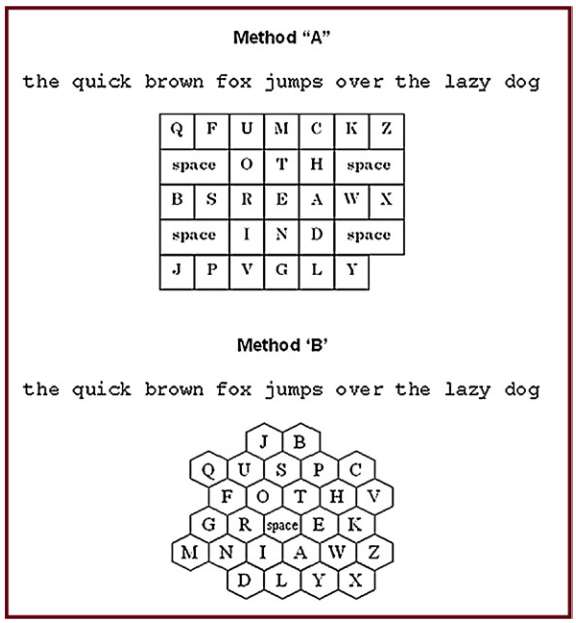
Mobile phone use should be banned during university lectures?

1	2	3	4	5
Strongly disagree	Mildly disagree	Neutral	Mildly agree	Strongly agree

Are males or females more likely to agree with this statement? Who knows, but this student exercise—along with a chi-square test, provides a mechanism to find out.

For the report, use the standard two-column conference format, using the ACM SIGCHI conference submissions template. The final formatted report should be three or four pages and include citations and references to at least four papers.

8-3. Recruit 10 participants for a study on text entry. The study will use a paper mock-up of two soft keyboards. Prepare a handout sheet containing images of two keyboards. The top half of the sheet contains the heading "Method A," with a phrase of text below. Use "the quick brown fox jumps over the lazy dog." Below the phrase appears the keyboard. The bottom half of the sheet contains the heading "Method B," with same phrase below, and with a different keyboard below that. The general idea is shown below:



For the two keyboards, use the Qwerty and Opti layouts in Figure 7.35 or any other layouts of interest. (The Metropolis layout by Hunter et al. [2000] is shown in the figure above.) Another possibility is to use two sizes of the same keyboard layout. (Is entry speed faster on the larger keyboard or the smaller keyboard?) Ask participants to enter the phrase by tapping on the keyboard image using a non-marking stylus. They are to enter the phrase five times on one keyboard, then five times on the other keyboard. Use a watch or other timing device to record the entry time for each phrase. Enter the times on a log sheet. Divide the participants into two groups and counterbalance the order of testing (see section 5.11). After testing is complete, enter the data into a spreadsheet. Convert the entry time t (in seconds) to entry speed s (in words per minute) using:

$$s = \left(\frac{43}{5}\right) / \left(\frac{60}{t}\right)$$

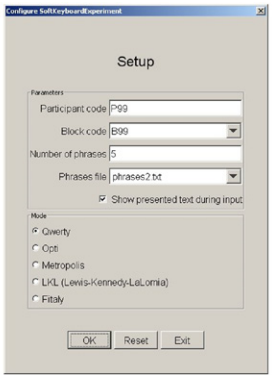
where 43 / 5 is the number of words and 60 / t is the number of minutes. Analyse the data for significant effects using an analysis of variance, as

outlined in Chapter 6. For the purpose of the ANOVA, the experiment has three independent variables: layout (A, B), phrase iteration (1, 2, 3, 4, 5), and group (AB, BA).

Write a research paper for the experiment, following the guidelines in this chapter. Use the standard two-column conference format, using the ACM SIGCHI conference submissions template. The final formatted report should be three or four pages. Include citations and references to at least four papers (e.g., research papers on soft keyboard layouts).

8-4. Recruit 10 participants for a study on text entry. Use a procedure similar to that described in the student exercise above. However, instead of using paper mock-ups, use the `SoftKeyboardExperiment` software provided on this book's website. The software supports five software keyboard layouts, as identified in the setup dialog (see below). Use any two. A screen snap of the experiment task is shown below. Note that data collection is automated in the software and includes additional dependent measures such as error rate and keystrokes per character (*KSPC*). Consult the API for further details.

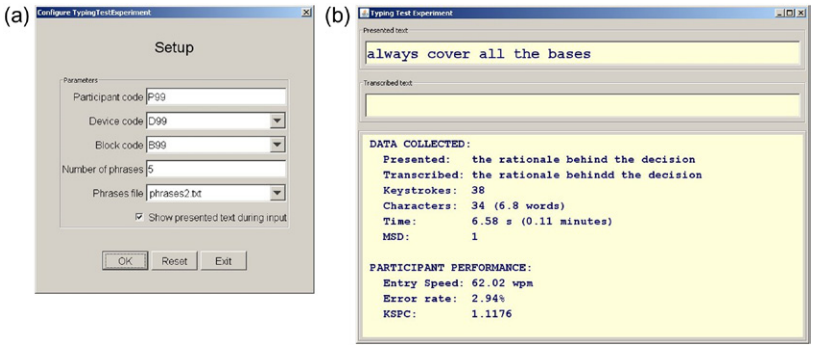
(a)



(b)

Write a research paper for the experiment following the guidelines in this chapter. Use the standard two-column conference format, using the ACM SIGCHI conference submissions template. The final formatted report should be three or four pages. Include citations and references to at least four papers (e.g., research papers on soft keyboard layouts).

8-5. How accurate are users in estimating their typing speed? Conduct a small experiment investigating this question. Recruit 10 participants and administer a brief questionnaire to each. Include a question asking them to estimate their typing speed on a desktop computer in words per minute. Then measure their typing speed using the `TypingTestExperiment` software provided on this book's website. The setup dialog and a screen snap of the experiment procedure are given below:



Configure the software for 10 phrases of entry. Compare the users' estimations with the observed typing speeds. Write a brief report on your findings.