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Gendered graphics: an examination of the effect of gender on visuals in professional communication

Michael Joseph Hassett
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Gendered graphics: An examination of the effect of gender on visuals in professional communication

by

Michael Joseph Hassett

A Dissertation submitted to the Graduate Faculty in partial fulfillment of the Requirements for the degree of DOCTOR OF PHILOSOPHY

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Major: Rhetoric and Professional Communication

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Iowa State University
Ames, Iowa
1995

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Gendered graphics: An examination of the effect of gender on visuals in professional communication

Michael J. Hassett

Major Professor: Rebecca Burnett
Iowa State University

This dissertation reports a study that examines the effect of gender on the creation and interpretation of visuals used in diagrams of the sunflowerseed oil extraction process.

Gender has long been considered an issue worth pursuing in studies of communication behaviors. Research completed on gender and communication can be divided into two areas: studies investigating performance differences between males and females and studies investigating the perception of differences between males and females. This dissertation explores definitions of gender and surveys research in gender and communication in both areas. It applies this research to the use of visual elements in professional communication.

The study of gender in visual communication can also be divided into performance and perception categories. Studies of performance differences in the use of visual material by males and females can be found in research in psychology, art and design, and in professional communication. This research indicates that males are better than females at many visual practices. Perception
research indicates that people hold stereotypes about male and female use of visual material. These perceptions create differential training and experience for males and females. This study examines both performance and perception differences in visual communication behaviors.

This study used 22 diagrams of the sunflowerseed oil extraction process created by undergraduates in a technical communications course at Iowa State University. The diagrams were given to 24 graduate student raters from six academic disciplines. The raters evaluated the diagrams for visual appeal and effectiveness. They also identified the amount of technical background and the gender of each designer. Raters were interviewed after the evaluations to determine the criteria they used for their responses.

Few significant results were found in performance differences. There were gender-based differences in the number of words and number of visual items used in the diagrams, in the use of angled and rounded corners, and in the use of masculine and feminine handwriting styles. Significant perception differences included raters perceiving female diagrams as more visually appealing although no more effective than male diagrams. Also, female designers were perceived as having less technical background/knowledge than male designers.
TO ANGELA AND MIKAYLA,
"WITHOUT WHOM, NOT"
# TABLE OF CONTENTS

**LIST OF TABLES** ........................................................................................................vi

**LIST OF FIGURES** ......................................................................................................viii

**ACKNOWLEDGMENTS** ..............................................................................................ix

**CHAPTER 1** **BRINGING TOGETHER GENDER, COMMUNICATION, AND VISUALS** ...1
  
  What do I mean by “gender”? ...................................................................................... 2
  
  Sex *versus* gender ...................................................................................................... 2
  
  How many genders are there? ..................................................................................... 6
  
  Gender in this dissertation ......................................................................................... 8
  
  Why study gender? ...................................................................................................... 10
  
  Research in gender and communication .................................................................. 13
    
    Performance differences related to gender ............................................................. 14
    
    Perception of gender differences .......................................................................... 19
    
    Combining performance and perception differences .............................................. 22
  
  Rhetorical status and gender ...................................................................................... 23
  
  Moving gender into visual communication .............................................................. 25

**CHAPTER 2** **GENDER DIFFERENCES IN VISUAL COMMUNICATION: PERFORMANCE AND PERCEPTION** .............................................27

  Gender differences as a matter of performance ......................................................... 28
    
    Gender and visual performance in psychological research .................................... 28
    
    Gender and artistic performance in art and design .................................................. 36
    
    Gender and graphic presentation in professional communication ....................... 39
  
  Gender differences as a matter of perception ........................................................... 44
  
  The need to examine performance and perception together .................................... 48

**CHAPTER 3** **DESIGNING A STUDY OF GENDER-BASED PERFORMANCE AND PERCEPTION DIFFERENCES IN VISUAL COMMUNICATION** ..........50

  Collecting student-designed diagrams .................................................................... 51
    
    Document creation .................................................................................................. 54
    
    Document modification ........................................................................................... 57
  
  Evaluating the student-designed diagrams .............................................................. 58
Can raters of a process diagram make consistent and accurate determinations of the gender of the diagram's designer? .............................................. 59
On what basis do raters make their determinations of designer gender? .............................................................................. 64
Can the traits used for gender determinations be quantified in the diagrams and positively correlated with the self-reported gender of the designers? ............................................................................. 66
Do the traits identified by the raters correlate with the raters' own gender identifications? ......................................................... 77
How do determinations of gender correlate with other evaluations of the diagrams, such as effectiveness, visual appeal, or designer knowledge? ................................................................. 78
Mixing methodologies ..................................................................... 79

CHAPTER 4 IDENTIFYING GENDER-BASED DIFFERENCES
IN THE STUDY RESULTS .................................................................. 82
The determination of designer gender ............................................. 83
Traits used in gender identification .................................................. 88
Rater-identified gendered design traits ............................................ 88
Quantification of gender identification traits ................................... 90
Rater identified traits and gender scores ......................................... 100
Gender identification and other evaluations .................................. 102
Correlation between gender score and other evaluations ............... 102
Determining the impact of visual appeal, technical rating, and effectiveness on gender identification .................. 103

CHAPTER 5 UNDERSTANDING THE RESULTS: GENDER, VISUAL COMMUNICATION, AND RHETORICAL STATUS ......................... 105
Performance differences: Cues for identifying social status .......... 106
Types of visuals .............................................................................. 107
Handwriting .................................................................................. 109
Number of words and visuals ......................................................... 111
Angled versus rounded corners ...................................................... 114
Implications for professional communication .............................. 115
Assigning rhetorical status: Perceptions of gender-based differences in the diagrams ............................ 116
Can raters of a process diagram make consistent and accurate determinations of the gender of the diagram’s designer? ................................................................. 117
On what basis do raters make their determinations of designer gender? ................................................................. 123
LIST OF TABLES

Table 2.1 Correlation of visual ability categories, visual tasks, and graphic presentations ........................................... 40
Table 3.1 Alignment of research questions with portions of the analytical procedures ..................................................... 51
Table 3.2 Male and female handwriting traits as identified by lay raters ................................................................. 68
Table 4.1 Sample of coded gender ratings from Group 1 ......................................................................................... 84
Table 4.2 Chi square comparing actual designer gender with Group 1 rated gender .............................................. 85
Table 4.3 Chi square comparing actual designer gender with Group 2 rated gender .............................................. 86
Table 4.4 Gender scores for designs rated by Group 1 ......................................................................................... 87
Table 4.5 Gender scores for designs rated by Group 2 ......................................................................................... 87
Table 4.6 Chi-square comparing access to handwriting with gender identification accuracy ............................. 89
Table 4.7 Traits raters used to identify designer gender ...................................................................................... 92
Table 4.8 Coding results of “male” and “female” handwriting features ............................................................... 93
Table 4.9 Comparison of writing gender to rated and self-reported gender .......................................................... 94
Table 4.10 Number of words used in male- and female-designed diagrams ......................................................... 96
Table 4.11 Number of visual items used in male- and female-designed diagrams ............................................... 97
Table 4.12 Ratio of words to visual items used in male-and female-designed diagrams .................................... 98
Table 4.13 Male use of four types of visual items ................................................................................................. 98
Table 4.14 Female use of four types of visual items .............................................................................................. 98
Table 4.15 Results of t-test on four types of visuals and self-reported gender of designers .................................. 99
Table 4.16 Number of angled corners in male- and female-designed diagrams .................................................... 100
Table 4.17 Number of rounded corners in male- and female-designed diagrams ................................................ 101
Table 4.18 Percentage of angled corners in male- and female-designed diagrams ................................................ 101
Table 4.19  Correlation table of Group 1 and Group 2 gender scores, writing gender score, word count, image-to-word ratio, and angled corner percentage .......................................................... 103
Table 4.20  Correlation table of Group 1 and Group 2 ratings of gender, technical major, visual appeal, and effectiveness .......................................................... 101
Table G.1  Description of lay raters in Group 1 .......................................................... 226
Table G.2  Description of lay raters in Group 2 .......................................................... 227
Table J.1  Diagrams selected for discussion in interviews with raters in Group 1 .......................................................... 232
Table J.2  Diagrams selected for discussion in interviews with raters in Group 2 .......................................................... 233
Table K.1  Group 1 lay rater gender identification responses .......................................................... 235
Table K.2  Group 2 lay rater gender identification responses .......................................................... 236
LIST OF FIGURES

Figure 1.1   Gender as a two-pole continuum............................................................... 7
Figure 1.2   Gender as a four-quadrant matrix............................................................ 8
Figure 2.1   Rod-and-frame question used to test spatial perception ...................... 30
Figure 2.2   Block rotation task commonly used to test mental rotation abilities ...... 31
Figure 2.3   Disembedding test used to determine spatial visualization abilities ...... 32
Figure 3.1   Example of “male” handwriting traits, from diagram 22 ...................... 69
Figure 3.2   Example of “female” handwriting traits, from diagram 7 ...................... 69
Figure 3.3   Example of visual elements identified as “replicas” ........................... 74
Figure 3.4   Example of visual elements identified as “stylized” ............................. 74
Figure 3.5   Example of visual elements identified as “indexical.” .......................... 75
Figure 3.6   Example of visual elements identified as “symbolic.” .......................... 75
Figure 3.7   Example of three angled and one rounded corners, from diagram 19 .... 77
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CHAPTER 1
BRINGING TOGETHER GENDER, COMMUNICATION, AND VISUALS

Gender has been an important element in the study of communication and language for many years. Well over 1,000 articles, books, and book chapters devoted to the study of gender as a variable in communication date back to the early part of the twentieth century (Graddol and Swann, 1989). Over time, this research has become more complex, more complicated, and more varied in its findings. However, as the number of documents devoted to gender research attests, it has become no less important, interesting, or useful. While gender has only recently and even then infrequently been considered an issue in professional communication, in this dissertation, gender is applied as a variable in the visual communication of technical information, the use of visual elements in documents designed for work or functional communication. The study presented here is intended to move the conversation about gender and communication more firmly into visual communication, an increasingly important area within professional communication studies.

In this introductory chapter, I do four things. First, I discuss the differences between gender and sex research, a distinction required because of the complexity and volume of research on gender and communication. Second, I identify the value of gender research in order to justify examining gender in visual communication as well as in professional communication as a whole. Next, I discuss the various focuses and findings of some of the gender and
communication research that is most relevant to this dissertation. I do not attempt to review all of the research, but I provide a survey of some of the research in which gender has and has not appeared as an identifiable variable in communication styles, strategies, and behaviors. This survey considers what I see as two differing approaches to studying gender and communication. One approach examines performance differences between men and women. The second approach studies the different perceptions of male and female communication behaviors. Finally, I suggest the necessity of moving the study of gender into research in visual communication and describe the questions with which my own research is concerned.

What do I mean by “gender”? 

At one point in the history of gender and communication research, using the terms gender and sex might have been unproblematic. Now, however, it is difficult to use either of these terms when talking about research without defining them. In this section, I draw a distinction between research that focuses on sex and research that focuses on gender. I discuss the usefulness of a view of gender that allows for something more than a simple binary distinction between male and female. Finally, I explain how I use the terms gender and sex throughout this dissertation.

Sex versus gender

The conflation of sex and gender has been a long-standing problem that has begun to see some resolution in the last two decades. In research into gender issues and communication prior to the 1970's, researchers “sometimes assumed
... that gender was a pre-given biological fact that produced differences in language use and interaction" (Rakow, 1992, p. 10). Kramarae and Treichler (1985), in *A Feminist Dictionary*, cite Warren's (1981) discussion about the confusion of sex and gender: "Gender is 'often used as a synonym for sex, i.e., biological maleness or femaleness'" (p. 173). Most researchers now distinguish between sex and gender, defining *sex* as a biological construct and gender as a psychological, social, or cultural construct. For example, Richardson (1991), in his review of "gender differences in imagery, cognition, and memory," defines *sex* as the "biological distinction between men and women that may be based upon their anatomical, physiological, or chromosomal features," while *gender* is the "sociocultural distinction between men and women on the basis of the traits and behavior that are conventionally regarded as characteristic of and appropriate to the two groups of people" (p. 272). Warren, cited by Kramarae and Treichler, describes gender as "the socially imposed dichotomy of masculine and feminine roles and character traits. Sex is physiological, while gender ... is cultural. The distinction is a crucial one" (p. 173).

Unfortunately, many contemporary researchers, although they attempt to distinguish carefully between the two, still conflate them, as do people in everyday conversation (Arliss, 1991). In general, however, as Arliss notes, *sex* "refers to a biological category. Each of us can be labeled either male or female at birth based on observable physical evidence." Gender, on the other hand, "cannot be assigned at birth, but must be inferred based on an individual's behavior" (p. 6-7). The behaviors on which gender decisions are based vary between individuals, communities, and cultures, and allow for some overlap (Arliss).
The continuing conflation of *gender* and *sex* makes it difficult to determine when researchers are talking about either one. Based on his definitions, Richardson (1991) suggests that in discussing the majority of psychology research it is appropriate to use "'gender differences' rather than 'sex differences' because in the vast majority of studies comparing the use of mental imagery in men and women the participants are categorized on the basis of their outward appearance and behavior rather than on the basis of their biological characteristics" (p. 272). In other words, researchers used outward social cues rather than biological properties in determining "sex"; therefore, their research should be more properly called "gender" research. Using Richardson's distinction, then, most psychology research concerning sex differences, as well as most research concerning sex differences in communication and many other fields, must be discussed as *gender* research. I'll use this distinction as I discuss definitions of gender.

Theorists conducting gender studies have developed new definitions of gender that critique, combine, and modify previous definitions. An examination of a number of these increasingly refined definitions, however, reveals some important constants. Grimm (1989) defines gender, interestingly within a section titled "'Sex Difference' Research," as the "expression of socially constructed feminine and masculine forms of behavior, validated by the social recognition of constructed realities and re-created in each generation by individual females and males for portrayal in the reality of a particular culture" (p. 336). Hess (1990) provides a similar definition, citing West and Zimmerman (1987): gender is "an 'achieved property of situated conduct . . . an emergent feature of social situations . . . and a means of legitimating one of the most fundamental divisions of
Gender is produced and reproduced in concrete social acts between women and men and among members of each group." (p. 84-85, first two ellipses in original). Both of these definitions emphasize the social nature of gender as well as its creation and re-creation within specific instances of interaction.

Another common aspect of many gender definitions is the combination of biological sex with other factors. Smythe and Schlueter (1989) define gender (which they refer to as "sex differences") as "the compelling and essentially unknowable combinations of biological, social, personal and behavioral factors that constitute femaleness and maleness" (p. 43). Hess (1990), also, incorporates a sense of biology into her discussion of gender, noting that

\[ \ldots \text{in all societies, layers of meaning have been wrapped around the one distinguishing feature of biological sex to produce a palimpsest of gendered reality—socially constructed systems of thought and action that organize perception, identities, and the allocation of scarce resources. (p. 83)} \]

Similarly, Unger and Crawford (1992) argue that gender is "what culture makes out of the 'raw material' of biological sex" (p. 18). They see gender as "based on sex;" it is this relationship that has led to the conflation of the two terms both in researchers' definitions and in lay people's practical attributions of gender differences to biological causes.

Gender seems best defined, then, as a combination of physiology, social interaction, personal psychology, and cultural stereotypes, much as Smythe and Schlueter (1989) define it. Added to this is the sense that gender also consists of social expectations of behaviors that exist prior to individual instantiations of those behaviors. Gender expectations can vary over time, across cultures, and
between communities. The most critical point, in terms of my dissertation, is that biological sex does not encompass gender, but gender does include biological aspects. As a result, sex differences that do not adhere to a strictly physiological definition of sex are best discussed in terms of gender, the broader, more inclusive category.

**How many genders are there?**

Because gender includes aspects of biological sex and because most people view biological sex as a dimorphous category, gender is typically viewed as having two types, male and female (or masculine and feminine). These two types reside on a continuum, with male/masculine on one end and female/feminine on the other. Unger and Crawford (1992) suggest that in the continuum conception of gender, male/masculine and female/feminine are mutually exclusive categories—"a person may be masculine or feminine, but not both" (p. 50). This continuum approach is represented in the Figure 1.1, which highlights the dichotomous nature of this conception of gender.

Another way to think about gender is as a four-quadrant system, with male/masculine and female/feminine forming the axes that section off the quadrants. This provides four "genders": male/masculine, female/feminine, androgynous, and undifferentiated. Androgyny refers to the occurrence of both male and female traits in an individual, while undifferentiation occurs when a person exhibits traits that are non-gendered, traits not typically identified as either male or female. The quadrant approach establishes both androgyny and undifferentiated as alternative genders. This addition of androgyny and undifferentiated genders creates a break from the traditional dichotomous view of gender which was tied to an emphasis on two biological types. One researcher
responsible for a good deal of work on androgynous and undifferentiated gender is Sandra Bem, whose work suggests that androgyny is a more useful gendered position than either masculinity or feminity (see, for example, Bem, 1975, and Bem and Lenney, 1976). A quadrant approach to gender places "maleness" and "femaleness" into a relationship and sees individuals as possessing relatively greater or lesser amounts of each. This is represented in Figure 1.2.

Because gender is not limited to biology in its development, the quadrant approach is a more useful framework for gender than a simple continuum. Unfortunately, when examining perceptions of gender difference in my study, I found using concepts such as androgyny and undifferentiated gender to be problematic since most people are used to thinking of two genders only. Asking my participants to select among male, female, androgyny, and undifferentiated seemed a potentially disconcerting and confusing request. Furthermore, such a request appeared to highlight the research interests of my study in a way that might unduly influence participants' responses. In my study, I allowed participants to identify gender along the two-pole continuum, choosing between male and female, but I also provided another choice, a certainty rating, that
allows for an identification of androgyny and undifferentiation within the
participants' choices. Chapter 3 describes this method in more detail.

Gender in this dissertation

Because the literature review I provide in Chapter 2 examines the same
type of research that Richardson (1991) discusses—psychology research
examining gender and visual abilities, as well as research in other fields based on
this psychology research—and because my own study does not attempt to
determine the biological sex of the participants, I have chosen to use gender
rather than sex throughout this dissertation. The term sex is used only in
quotations from other researchers' documents, but unless specifically identified
as having focused on verified biological sex, it should be understood that I see
the researcher as having actually studied *gender*, the combination of physiological, social, personal, and cultural expectations of males and females.

In addition, my use of gender rather than sex echoes Chafetz’s (1990) use of the term. Chafetz uses gender rather than sex to convey the

... opinion that, for the theoretical questions addressed here, biology does not constitute a relevant variable. Rather, it is sociocultural definitions of, and reactions to, biological sex that produce and reinforce inequality between males and females. ... The phenomena of interest in this book are aspects of gender systems that can and have varied and, therefore, must be explicable by phenomena that vary. (p. 28)

In using the term *gender* rather than *sex*, I attempt to foreground similar concepts: that gender is a social construction of characteristics and traits, that these characteristics and traits can change, and that gender is used socially to construct unequal evaluations of male and female communicative performance.

Furthermore, since my research is designed to be exploratory and descriptive rather than definitive, I resist developing narrow, strict definitions of gender and gender categories, preferring a description of gender and gendered attributes as developed by the participants in the study. The study has been developed in such a way that while participants make a dichotomous choice between male and female, the certainty ratings allow gender in the study to be seen as male/masculine, female/feminine, undifferentiated or androgynous. This approach should allow the widest discussion and description of my research results.
Why study gender?

There has been a great deal of research done concerning what gender is, how it affects people's lives, and how it affects their interactions with others. At least one question that all of this research raises is, why study gender? More specifically, for my research, the question might be rephrased, why study gender as a variable in communicative interactions? There are three parts to my response to that question: one, gender is a pervasive influence in our lives and our interactions; two, human beings continue to be preoccupied with gender and its effects; and three, because gender has been used as a basis for discrimination, we need to understand it more fully in order to alleviate the impact of that discrimination.

Spence (1993) provides some insight about how pervasive gender is as an influence on the lives of human beings, noting that "the firm sense of gender identity most people develop in early childhood remains a central part of their self-image throughout their lives" (p. 633). Individually, then, gender is constant and central. But it is also, as noted above, a social phenomenon, so that its pervasiveness extends beyond individual experience. Unger and Crawford (1992) explain that gender operates not only at the individual level, but also at the interpersonal and social levels, influencing "behavior, thoughts, and feelings in individuals . . . interactions among individuals; and . . . the structure of social institutions" (p. 18). Chafetz (1990) argues similarly that "gender permeates all aspects of sociocultural and personal life in most societies" (p. 28). Bordo (1990) suggests that, at the moment, gender cannot be avoided in Western culture.

Our deepest desire may be to "transcend gender dualities," to not have our behavior categorized as "male" or "female." But, like it or not, in our
present culture, our activities are coded as "male" or "female" and will function as such within the prevailing system of gender-power relations. (p. 152)

Something so prevalent and unavoidable in personal and social experience seems worth investigating.

The amount of research undertaken in gender studies indicates the extent to which academics are preoccupied with gender. The current success of popular books about men and women and their differences—books such as Tannen’s (1990) You Just Don’t Understand or Gray's (1992) Men Are From Mars, Women Are From Venus—also shows how preoccupied people other than academics are with this subject. Arliss (1991) suggests that our preoccupation involves a desire to divide the "human race into males and females, regardless of age and regardless of our vested interest in knowing. We feel unbelievably anxious if we do not know this particular information about another person" (p. 2). Arliss explains that this preoccupation might be based on our need to "understand and evaluate behavior" (p. 2). We feel that we have to know gender in order to know whether a person’s behavior is appropriate or inappropriate. This preoccupation leads to a variety of accurate and inaccurate judgments, and it is these judgments that justify pursuing how people understand and act upon gender.

Finally, extending this idea of gender-based judgments, we need to examine gender issues, especially in communication, because of the discrimination and unequal treatment that result from judgments, especially inaccurate judgments. Arliss (1991) explains that the judgments people make based on gender are often implicitly made and implicitly passed on to others. In
order to understand how we discriminate, how we develop and apply these implicit judgments unequally to the detriment of one gender, Arliss argues we need to understand how people differentiate between the genders. Differentiation, however, may not be the most important aspect of gender research. Hess (1990) argues that it is not difference, but unequal treatment that matters. In other words, it is one thing to note that there are real differences between genders; it is another to develop differential treatment based on those differences. Equality, which involves understanding “both differences and similarities . . . may not be attainable without taking sex [gender] differences into account” (p. 88).

Approaching gender from the standpoint of seeking change is in keeping with feminist critiques of gender that foreground the hierarchical structures embedded in concepts of gender in Western culture. Feminist critiques of gender have undermined the idea that it exists as a neutral concept in people’s experience. Besides being socially constructed, gender also provides a method for establishing and maintaining social hierarchies. Kramarae (1989) argues that whenever gender is used, hierarchy must also be understood. Gendered attributes are created in the pursuit of maintaining hierarchical relationships between groups of people. This argument is similar to Grim’s (1982) that gender-based differences are used as a justification for social practices that treat men and women unequally: “The form of this argument should be familiar: our data shows that men and women differ in certain ways, and those differences (so the story goes) justify a differentiation of social roles along sexual [gendered] lines” (Grim, p. 129).
The goal that justifies gender research, then, is to provide a more accurate understanding of differences and similarities between genders and to identify inaccurate and detrimental judgments that lead to unequal treatment of one or the other gender. Grimm (1989) phrases the goal this way: “the goal of any such research [involving gender] should be to affect our socialization practices and policies for the good of both individual females and males and for a world which needs the talents of all its members” (p. 336). The ultimate justification for investigating gender in communication, then, is the opportunity such investigation affords to understand and alter how people view gender and to eliminate detrimental judgments based on gender.

**Research in gender and communication**

As noted in the introduction to this chapter, there have been more than 1,000 articles, chapters, and books devoted to the investigation of gender as a variable in communication. Most researchers trace this line of study to Otto Jesperson’s 1922 work, *Language: Its Nature, Development, and Origin* (Graddol and Swann, 1989; Smythe and Schlueter, 1989; Wareing, 1994); however, at least one researcher traces such research to 1908 (Riley, 1992). Gender and communication research saw a particular resurgence in the 1970’s, due in large part to the work of Robin Lakoff (Smythe and Schlueter, 1989; Tannen, 1990). Because of the large amount of research, the number of researchers, and the continuing identification of new research questions, Booth-Butterfield (1993) argues that the “social-scientific” study of gender and communication has become a complete research paradigm in the Kuhnian sense. Similarly, Turner
(1993), following Kramarae's (1989) argument, suggests that gender has become "a central organizing concept for studying language and communication" (p. 492), particularly in speech communication.

Despite the number of studies and theoretical works and the number of researchers working on this topic, there has been very little agreement about the exact nature of the relationship between gender and communication during the past 75 years. Researchers continue to struggle with the questions of whether and how gender might affect people's communicative behaviors and interactions. In this chapter, I do not attempt to resolve these issues, nor do I attempt to survey all of the material that has been written on these questions. Instead, I provide a survey of some of the contradictory findings of gender and communication research. My point is to show, as Smythe and Schlueter (1989) argue, that the "accumulation of findings and the apparent discrepancies within the literature warrant exploration" (p. 35). To facilitate this survey, I divide the research into two areas, the study of actual differences in communicative behaviors, what I term performance differences, and the study of the identification of and reaction to supposed differences, what I call perception of differences. In dividing the research this way, I am following the lead of Smythe and Schlueter, who separate "sex-difference [gender-difference] effect in terms of language production" from "the perceptions occasioned by those differences" in their meta-analytic review of this field of research (p. 38).

**Performance differences related to gender**

A number of researchers have provided overviews, reviews, and meta-analyses of the research about gender-related performance differences (see, for example, Cameron and Coates, 1985; Graddol and Swann, 1989; Smythe and
Schlueter, 1989; Arliss, 1991; Condravy, 1993). All of the researchers seem to agree that the study of performance differences is replete with inconsistencies and contradictions. Virtually every study that finds a gender-based difference in one area of communicative behavior is followed by one that finds no difference in that same area. To further complicate matters, some research seems based primarily on anecdotal information or informal observation of behavior, while other research is based on rigorous experimental testing or systematic qualitative research. Some research findings have been called "folklinguistics," suggesting that they are based more on long-held stereotypes rather than real research (Cameron and Coates; Arliss; Wareing, 1994). In spite of these contradictions, there is sufficient consistency that respected researchers feel justified in arguing that "variation associated with the sex [gender] of the speaker is now well-documented in speech communities as different as New York, Mombasa, Belfast, and Norwich" (Cameron and Coates, p. 143). In this section, I review some of the contradictory findings concerning gender-based differences in communicative performance.

One of the most often-cited (both by those who support and those who oppose the idea of gender differences in communication behaviors) researchers in gender and language studies is Robin Lakoff, who in 1973 published an article titled "Language and Woman's Place" and in 1975 followed it with a book of the same title. In these pieces, Lakoff argues that there are male and female differences in vocabulary and syntactic pragmatic traits (e.g., tag questions and hesitations). Other researchers have examined these communication patterns with varied results. Crosby and Nyquist (1977), for example, conclude with Lakoff that there is, indeed, a "female register" characterized as being "expressive
(e.g., polite rather than direct and informative) and non-assertive” (p. 314; see also Allen, 1991; Tannen, 1990; and Adler and Rodman, 1991). Other researchers cast doubt on Lakoff’s arguments, suggesting that there are no differences in the characteristics of male and female communication patterns (see, for example, Dubois and Crouch, 1975; Kennedy and Camden, 1982).

Condravy (1993) in a survey of “women’s talk” research, identifies research that found gender-based differences in vocabulary, interactional strategies, lexical styles, tag questions, use of imperatives, and the existence of a “‘genderlect,’ a way of speaking . . . identified as characteristic primarily of women or men (Tannen, 1990)” (p. 400). However, as noted above, Condravy identifies research in each of these areas that found no differences attributable to gender. Some of the research found that no differences existed in use of features, such as lexical choice. Other research found that differences that did exist were attributable to other variables, such as power. Condravy suggests that a large part of the inconsistencies involved in this line of research can be attributed to weak methods, including problems of research context and the introduction of researchers’ own stereotypes into the interpretation of results.

Another list of gender-based differences can be found in Spitzberg and Brunner (1989), who identify differences in language use, conversational cues, nonverbal skills, disclosure, power strategies, leadership styles, conflict management, and “a variety of objective, interpersonal behaviors” (p. 121). In the same collection of essays, Smythe and Schlueter (1991) argue, as a result of their meta-analysis of gender and communication research, that there are “strikingly few actual differences [that] have been reliably and validly documented” (p. 39). However, their analysis does identify at least fifteen studies.
that found statistically significant gender differences in behaviors such as
utterance rate, word rate, total talk, word count, word variability, verbalizations,
speaking turns, and interruptions, which would seem to support at least some of
the research into gender-based differences into performance and to suggest that
other differences might be reliably studied.

Much of this contradictory research has examined oral communication
behaviors. Composition researchers who have only recently begun to
investigate gender as a variable have identified differences in male and female
composing behaviors. Flynn (1990) argues that because “women and men differ
in their relational capacities and in their moral and intellectual development, we
would expect to find manifestations of these differences in the student papers we
encounter in our first-year composition courses” (p. 117). Flynn then goes on to
describe four essays, two by female students and two by male students, that
exhibited differences in the way in which they were written. The female-
authored texts were “stories of interaction, of connection, or of frustrated
connection. The narratives of the male students [were] stories of achievement,
of separation, or of frustrated achievement” (p. 117). Similarly, Gabriel (1990)
argues that because gender affects how people read, it will also affect how people
write in response to reading. Both Gabriel and Flynn seem to agree that “we
ought not assume that males and females use language in identical ways or
represent the world in a similar fashion” in their written communication
behaviors (Flynn, p. 121).

In addition to empirical research, theoretical work with women and
composition indicates important performance differences. Herndl (1991) cites
French feminists such as Luce Irigaray, Hélène Cixous, and Julia Kristeva in
describing *l’écriture féminine*, or "feminine writing." This theoretical concept suggests that there exists a form of writing that is "specifically gendered" as female although it is not possessed or exhibited only by "biologically sexed females" (p. 331). The existence of this feminine writing is perceived by some researchers as more of a theoretical ideal than an empirical reality (Jones, 1991). However, it has served as a significant concept for some researchers who study gender and communication. Bosley (1992), for example, seems to rely at least in part on this theoretical construct of feminine writing in her analysis of gender and visual communication. (Bosley's study is described in Chapter 2.)

Researchers studying gender and writing in professional communication, on the other hand, have not found gender differences. Three studies of students (Smeltzer and Werbel, 1986; Sterkel, 1988; Tebeaux, 1990) found no significant differences related to gender in the students' construction of written business-oriented documents. Where differences in documents did occur, these researchers were able to attribute them to other variables, such as job-related experience (Tebeaux) and document genres (Sterkel).

The research findings concerning gender and communication performance seem as varied as the people and contexts in which the research has taken place. Reviews of the literature in this area leave a consistent impression, however: the sheer weight of our preoccupation with the issue and the sense of what Smythe and Schlueter (1989) identify as the "strength and enduring character of sex-based [gender-based] linguistic stereotypes" (p. 35). Even though studies contradict one another, researchers continue to find results that support the contention that there are differences in the ways men and women perform communicative acts. It is the preoccupation, enduring effects, and the sheer
accumulation of material that make gender performance differences a source of continuing research questions.

Perception of gender differences

The second area of research in gender and communication, although somewhat less developed than the study of performance differences, is the study of the perception of gender differences, regardless of actual performance differences, or what Smythe and Schlueter (1989) refer to as "other-perceived behaviors" (p. 35). This research typically examines how people respond to language behaviors that are thought to be gender-marked. Specifically, Smythe and Schlueter draw on Mulac and Lundell (1980) in defining this perception-based research in oral communication studies as research that has focused on the attributions listeners make about speakers on the basis of linguistic cues, the evaluations associated with certain configurations of language cues (powerful/powerless speech) and the specification of linguistic markers of sex (gender-linked-language effect) (Mulac and Lundell, 1980). (p. 36)

In essence, this type of research investigates stereotypes about male and female language behaviors as more than the behaviors themselves. Hoar (1992), in defining "genderlect . . . speech that contains features that mark it as stereotypically masculine or feminine," argues that this is a stereotype of "expected as well as observed behavior" (p. 127).

The study of perceived gender differences has been important in research involving lexis, the study of vocabulary choices (Wareing, 1994). Wareing suggests that Robin Lakoff's work should be placed in this category because she used "her own intuition, not empirical research," which apparently indicates a
reliance on perceived differences (p. 36). In addition, Wareing goes on to argue that perceptions about language use develop in childhood and that these perceptions are independent of even the holder's own language behaviors. Wareing concludes that the perception that certain lexical choices are appropriate for and typically used by men while others are appropriate for and typically used by women is a deeply held belief.

Similar to lexical choices, male and female workplace interaction styles have been studied in terms of perceived behaviors although these findings have been mixed. Ragins (1992), in her survey of research into gender and evaluations of managers, identifies research indicating that female leaders receive lower evaluations from their subordinates. She also finds research indicating that female leaders are rated equal to or higher than male leaders. Ragins suggests that the discrepancy may be caused by power differentials rather than gender, and that because females are more often in lower power positions, the results may appear skewed toward males. However, Ragins goes on to claim that because gender and power are linked, females may continue to receive a higher ratio of negative evaluations.

Pruett (1989) claims that perceived interactional styles is the one gender difference in communication that has remained constant. In Pruett’s analysis, style is an important variable because it concerns the interpretations of individuals who are receiving messages from the communicator. Style, as Pruett defines it, is “the message’s interpretation by the receiver and its impact on what is being said and how it is being said” (p. 107). Women are “perceived to be and report being expressive communicators while men are more often perceived as and report being instrumental communicators (Pearson, 1985; Wood, Polek, &
Expressive communication styles emphasize interpersonal relationships while instrumental styles emphasize informational content. Much of the research done on perceived gender differences could be said to about interactional style, as Pruett defines that term, since this research focuses on how perceived behaviors affect evaluations of and responses to messages.

One method for studying perceived gender differences in written communication has been to present the same written document to various readers while altering the gender of the alleged author of the document. Goldberg (1968), in an early version of this type of study, presented professional articles from a variety of disciplines to two groups of college-age women. For one group, an article would have a male author while for the other group the same article would have a female author. These women rated the articles for "value, persuasiveness, and profundity—and to rate the authors for writing style, professional competence, professional status, and ability to sway the reader" (p. 30). Generally, the results of the study indicated that women were much more likely to rate male authors more highly than female authors, even for articles written in disciplines traditionally considered female.

In a more recent example of this concealed-gender reading study, Haswell and Haswell (1995) examined how perceived gender affected the critiques of two student-authored essays by students and by teachers of college composition. Haswell and Haswell did find significant effects caused by the perceived gender of the author. When readers were told that one of the essays was written by a woman, for example, they gave a more positive response, while when told that
the other essay was written by a man they gave it a less positive response.

Haswell and Haswell argue that their results showed that gendering of student writing during critiques involves more factors than just gender bias. . . . teachers and students do more than bring gender stereotypes to a student text. They also use gender signals in the text . . . to establish a notion of the writer's sex, and they use gender protocols . . . to deal with the writer's signals and with their own stereotypes. And to the interpretive act they also bring a sense-of-self that itself is deeply gendered. It is a complicated action. (p. 225)

Compared to the research concerning gendered performance differences, there seems to be less conflict and contradiction involved in studying the differences in perception of male and female communication behaviors. Although as Ragins notes, the differences may be complex and related to other, non-gender issues, people continue to hold expectations and stereotypes about how men and women communicate. These perceptions become significant aspects of how people interact with one another and evaluate the messages that are communicated.

Combining performance and perception differences

Booth-Butterfield (1993) argues that additional research is needed to adequately understand how gender affects communication. One of the directions Booth-Butterfield identifies for further research is the investigation of "communication behaviors and subsequent reaction to the behaviors" (p. 380). While studies have tended to focus on one or the other, sometimes even conflating the two unknowingly, no studies have attempted to study both aspects more or less simultaneously. Such a study might allow for the type of
integration of findings that Booth-Butterfield suggests would be useful for the field of gender and communication studies. The study I report on in this dissertation attempts to serve as a starting point for this type of research by developing a method in which behaviors and reactions to those behaviors become mutually informative.

**Rhetorical status and gender**

One way of understanding the manner in which gender-based performance and perceptions work together in communication is through Logue and Miller's (1995) concept of rhetorical status. Logue and Miller offer rhetorical status as a concept for communication studies in an effort to explain how personal qualities, social standing, and communication contexts work together to determine the outcomes of specific communication events. They define rhetorical status as "the relative standing or positioning of parties to communication or . . . this standing as reflected in the identities that interacting parties assign to themselves and to others as communicators" (p. 41). When two communicators interact, they assign each other status positions depending on contextual and personal variables that they both perceive, exhibit, and interpret. These status positions are used by both communicators to interpret and evaluate messages that are communicated during the interaction.

Rhetorical status works through a series of judgments made by communicators. Logue and Miller argue that the way in which rhetorical status affects communication follows this pattern:
• First, communicators identify one another’s “social status,” socially-constructed identities—such as race, gender, age, education—that come with some sort of socially-established value.

• Next, based on social status, communicators rank and type one another. Logue and Miller note that this ranking and typing on the basis of social status means that “persons of a particular sex [gender], race, religion, or occupation are often treated as if they hold more or less the same rank in competence, intelligence, or merit, regardless of their individual qualities” (p. 26).

• Next, communicators assign one another a rhetorical status, a hierarchical placement of the other communicators relative to themselves, based on the typing and ranking that has occurred and relative to the context in which the communication takes place. Logue and Miller suggest that rhetorical status varies with context. In a “discourse on automotive maintenance,” a “head of state” would most likely defer to a “filling station attendant,” even though their rankings based on social status would suggest otherwise (p. 27).

• Finally, rhetorical status serves as a mediating force, filtering messages and influencing interpretations by both communicators, and thus affecting the specific outcome of the communicative interaction. This concept of rhetorical status can provide a useful framework to explain how gender works in communicative interactions.
Moving gender into visual communication

One aspect of communication that has fairly recently become of interest is the visual communication of information. In professional communication, the visual presentation of information has always been important. That importance has led to the development of units within business and technical writing courses and textbooks, entire undergraduate and graduate courses, and entire books devoted to the study of using visual elements in written documents and on the computer screen. In composition, in general, visual communication is becoming more important. Kress (1995) argues that where visuals once served as illustrations in text-primary documents, text now sometimes serves as commentary in visual-primary documents. This change from a text-based to a visual-based communication mode is forcing a re-thinking of many of the issues traditionally prominent in communication studies. One area that needs additional study is the role of gender in visual communication.

As indicated above, gender is an important concept, both in people’s experiences and in communication studies. Unfortunately, gender has not influenced to any great degree the study of visual communication. As the survey in Chapter 2 of literature devoted to the study of gender and visual communication in professional communication reveals, there are only a handful of studies that deal with this issue. Individually, none of those studies recognizes the differences between perceived differences and actual performance differences as described above—each study deals with either one or the other concept. At the same time, there is ample evidence that gender might have effects on visual communication similar to those it has on written and oral communication, both in terms of affecting perceived communication behaviors
and in affecting actual behaviors. If gender is, indeed, a central organizing concept in language and communication research, then it would seem necessary to bring that organizing concept to bear on visual communication research.

The remainder of this dissertation describes a study of perceived and self-reported gender-based differences in visual communication behavior. The overall issue with which the research concerns itself is the question of whether gender ought to be considered a legitimate variable in the study of visual communication. However, the study is designed to begin a conversation by raising important issues, not to end one by developing definitive answers. In addition, it attempts to develop at least one method for examining perceived and actual differences almost simultaneously, allowing these two research focuses to enhance and comment upon each other. Chapter 2 is devoted to a survey of research concerning gender and visual communication from perceptual psychology, art and design, and professional communication. Chapter 3 describes the method of the empirical investigation I carried out, while Chapter 4 presents the results of that study. Chapter 5 examines the results in terms of their relation to gender and communication research in general, as well as their importance for professional communication practice and pedagogy more specifically. One way of understanding how gender affects visual communication is through Logue and Miller's (1995) "rhetorical status," a concept that explains how people use socially-constructed identities in specific communicative interactions. In Chapter 5, I will use rhetorical status as a framework for discussing the results of this study.
CHAPTER 2
GENDER DIFFERENCES IN VISUAL COMMUNICATION: PERFORMANCE AND PERCEPTION

The focus on performance and perception related to gender and communication provides a framework for examining gender as a factor in visual aspects of communication. If visual representation can be considered a form of communication, then it seems logical that many of the issues involved in research into gender and communication might also be involved in the ways people use visual elements in communication. The division between performance and perception that occurs in research in gender and communication can be used to categorize research into gender and visual communication.

Research into performance differences, studies that attempt to show how men and women use visual information differently, can be found in psychology, art and design, and professional communication. (Here, “use” can be taken to mean either produce or interpret visual information, although the bulk of work in psychology deals with viewing rather than creating visuals.) Research involving the issue of gender-based preferences is generally found only in art and design research. In this chapter, I examine the research in gender and visual communication, dividing it into gender-based performance differences and gender-based perceptions. I then show how existing research creates a need for further study of gender and visual communication, particularly research that allows both performance and preference to be combined.
Gender differences as a matter of performance

Gender-based performance differences in visual communication, both in the production and interpretation of visual materials, are studied in three fairly distinct disciplines: psychology, art and design, and professional communication. Each discipline contributes something different to the conversation about how gender may or may not affect the ways people create or interpret visual material. However, the research in these disciplines has a common theme: an emphasis on performance, how men and women actually perform under various conditions. Part of this performance orientation can be attributed to the reliance of art and design and professional communication on psychology for research methodologies and theoretical frameworks. As with research in gender and communication, however, the results of performance studies of gender-based differences in psychology, art and design, and professional communication are mixed, indicating both differences and no differences between males and females.

Gender and visual performance in psychological research

Psychologists often study visual perception under the more general rubric of visual-spatial ability, and it is this aspect of psychological study that seems most applicable to a discussion of visuals in professional communication. One of the most often studied variables in psychological examinations of how people use visual materials is the issue of gender. Psychologists have for many years considered the question, “Does a person’s gender affect how that person comprehends or produces visual material?” In psychology, then, the issue is one
of performance, whether gender differences actually lead to differences in performance with visual information.

Unger and Crawford (1993) suggest that because of the complexity involved in studying gender and spatial ability, meta-analyses provide the most useful information. They go on to suggest using the meta-analysis provided by Linn and Petersen (1985). Linn and Petersen, using a meta-analysis of 175 studies involving gender and performance, develop three categories of spatial tasks: *spatial perception*, which involves the orientation of a visual stimulus with the perceiver's own body; *mental rotation*, which involves turning pictures of an object in different directions and mentally establishing how the object might look from various angles; and *spatial visualization*, which involves mentally following a multi-task procedure presented through a series of visual images. Psychologists have found gender-based differences in performance in each of these areas.

**Spatial perception**

In studies of spatial perception, Linn and Petersen (1985) note that gender differences found in the studies considered in their meta-analysis were significant, particularly when dealing with study subjects over the age of eighteen years. Studies completed after the time period included in Linn and Petersen's meta-analysis have supported this conclusion. For example, Liben (1991) found in an examination of 100 college students that male performance on a spatial perception task far surpassed female performance. Figure 2.1 provides an example of a task used to test spatial perception abilities.
Mental rotation

Linn and Petersen's (1985) meta-analysis shows that mental rotation is the source of the largest difference in female and male performance in visual ability tests. In addition, Geary, Gilger, and Elliott-Miller (1990) and Goldstein, Haldane, and Mitchell (1990) found significant and reliable gender-related differences in mental rotation performance in studies done with college students. All of these studies have shown that males outperform females in tests of mental rotation ability. Figure 2.2 is an example of block rotation task commonly used to test mental rotation abilities.

Spatial visualization

Spatial visualization is the least documented of the three categories. Linn and Petersen (1985) note that the studies in their meta-analysis showed no reliable gender-based difference for any age groups on tests of spatial
visualization. In part, this area of study is compounded by the difficulty of separating spatial visualization from mental rotation and perhaps even spatial perception. For example, Boardman (1990) places mental rotation under spatial visualization in his analysis: "Spatial visualization is an ability to manipulate or rotate two- and three-dimensional pictorially presented visual stimuli" (p. 61). Figure 2.3 provides an example of a representative spatial visualization task.

There is at least some evidence that the male/female differences in visual ability described by Linn and Petersen (1985) as well as the other researchers cited here may be cross-cultural. Mann, Sasanuma, Sakuma, and Masaki (1990) report that higher male performance on mental rotation tests were found in tests of children in both the United States and Japan. Similarly, Sanders, Soares, and D'Aquila (1982) report on what they term the "Hawaii family study," performed by Wilson and Vandenberg (1978), which used a "large sample of subjects from several ethnic groups" and found "a statistically significant sex [gender] difference in favor of males" (p. 1108).
Figure 2.3 Disembedding test used to determine spatial visualization abilities. Test subjects are asked to answer the question, "Is figure A part of figure B?" (From "Issues of gender in spatial reasoning," by S.D. LaPierre, 1993, paper presented at the National Art Education Association, Chicago, Illinois.)

The studies identified by Linn and Petersen (1985), as well as the additional studies cited above in support of Linn and Petersen's conclusions, all deal with performance in visual perception, how a person comprehends visual material already created. Other researchers have examined how gender affects the production of new visual material. Boardman (1990), for example, reviews a number of psychology studies of visual ability, especially as it relates to map skills in children. Boardman reports on studies that support, as do the studies discussed above, the notion that boys and girls read visual material, specifically maps, differently. However, Boardman also presents evidence that map drawing skills differ between boys and girls. Boardman cites studies by Mathews (1984, 1986) and Hart (1979) that found that "maps drawn by boys were more accurate and complex in form, showing a good understanding of spatial relationships... boys demonstrating a higher level of spatial competence in their mapping" (p. 62). Munroe, Munroe, and Lansky (1976) also identify differences in male and
female production of visual items, noting that male designs are "angular, protruding, and expanded," while female designs are "more typically rounded, indented, and internally elaborated" (p. 139) While the findings of researchers dealing with the production of visuals are not placed within the framework provided by Linn and Petersen's three categories, it seems reasonable that a connection between visual ability and visual production might exist.

Examining other variables

There is disagreement on the connection between gender and visual/spatial ability among perceptual psychologists, even though a number of researchers accept these connections as a given. Researchers have identified variables that might undermine the gender-ability connection, some of which focus on issues related to the research participants, such as gendered self-concept, experience, age, while others deal with testing methods, such as timing and scoring.

Gendered self-concept

A significant number of studies link spatial ability to an individual's self-concept, particularly whether the individual views herself or himself as masculine or feminine, or to a lesser extent androgynous. Signorella and Jamison (1986) provide a meta-analysis of 73 studies of gender self-concept and its relationship to spatial ability. In these studies, the subjects were given gender self-concept inventories such as the Bem inventory or the Nash ideal self inventory. The subjects' scores were then used to determine the relative masculine, feminine, or masculine-feminine (an equal emphasis on both styles) nature of the subjects' personalities.
Signorella and Jamison (1986) explain that higher masculine or masculine-feminine scores were correlated with improved mental rotation performance in both male and female subjects. Higher masculine and masculine-feminine scores for female subjects were also correlated with better spatial visualization scores. They conclude that gender self-concept is an important factor in gender differences in performance on visual ability tests.

In a longitudinal study of 60 females, Newcombe and Dubas (1992) support Signorella and Jamison's findings, reporting that spatial ability could be predicted on the basis of the masculinity rating of the subject's self-concept. Ozer (1987) also provides support for such a connection and notes that the connection between self-concept and spatial ability is found in female subjects but not in male subjects. In contrast, Goodrich, Damin, Ascione, and Thompson (1993), in seeking to replicate earlier findings concerning "sex [gender] role orientation" and visual-spatial ability, found no connection between Bem scores and performance, but did find a significant main effect for gender.

Experience

Experience can also play a role in spatial performance, and that role can look like a gender effect because of differences in male and female experiences. Goldstein, Haldane, and Mitchell (1990) note that experiential factors are often ignored in tests of spatial ability, and they explain that male subjects tend to have more experience with spatial tasks [although few researchers detail what they mean by "more experience"]; thus, males work through spatial problems more quickly and more confidently than females. Their conclusions are corroborated by Linn and Petersen's (1985) meta-analysis; Linn and Petersen, however, explain that the difference may be related to differences in strategy selection rather than
differences in ability—since males have more experience, they have more effective strategies available to them than do females.

Age

Persaud (1991) tested over 100 college students ranging in age from 20 to 56 years old on spatial analogy problems. His results showed a significant correlation between age and performance, but no correlation between gender and performance. Liben (1991) notes that development of the ability to use vertical and horizontal coordinates is "a relatively late accomplishment" (p. 285). And the meta-analyses of both Linn and Petersen (1985) and Signorella and Jamison (1986) indicate that age is a significant factor in performance differences on spatial tests and that age is linked to other variables, such as gender self-concept.

Test format

The manner in which spatial tests are administered and scored can influence the performance of test subjects, particularly female test subjects. When tests are timed, emphasizing the need for rapid solutions, female scores decrease (Linn and Petersen, 1985; Goldstein, Haldane, and Mitchell, 1990; and Newcombe and Dubas, 1992). Linn and Petersen conclude that when rapid solutions are not required, male and female scores on spatial ability tests become nearly equal. Since females tend to work through spatial problems more slowly (Goldstein, Haldane, & Mitchell, 1990), timed test situations may mask equivalent abilities. Goldstein, Haldane, and Mitchell note that when spatial ability tests are scored on the basis of raw number of problems correct, males have higher scores. When tests are scored on the ratio of number correct to number attempted, male and female scores become equal. Female subjects
appear to be more hesitant about guessing, and as noted above they work more slowly, so they attempt fewer questions than do male subjects. Goldstein, Haldane, and Mitchell summarize the importance of the effect of testing conditions on male and female performance when they say that "under standard [i.e., timed, raw-scored] testing conditions, males have higher scores than females on tests of spatial ability" (p. 549).

**Focus on performance**

Regardless of the agreement or disagreement on whether gender is the primary variable for creating differences in how people interpret and produce visual material, psychological studies share a focus on performance. These studies are all interested in determining whether there is a difference in performance and, if so, what might contribute to the performance differences. Studies of gender and graphics in art and design and in professional communication have followed the lead of psychologists in examining issues of performance, attempting to determine whether and/or how gender might affect how people produce or interpret graphic items that might be used in professional communication.

**Gender and artistic performance in art and design**

Part of the performance-oriented work in art and design is based on anecdotal, rather than empirical, notions of gender differences. Dorothy May Anderson (1980) provides an example in her historical examination of The Cambridge School, a landscape architecture program for women offered at Harvard in the early part of the twentieth century. As part of this examination, Anderson notes that Henry Frost, the founder of the The Cambridge School,
"was convinced that women did better work than men in the residential field, partly because he felt that they had a flair for design related to the human scale and partly because they paid more attention to detail" (p. 41).

Clare Lorenz (1990) offers a slightly different perspective in the introduction to her discussion of women in contemporary architecture. During her research into the lives and work of modern female architects, Lorenz was often asked, "Is it possible to tell whether a building has been designed by a woman or a man?" Lorenz's response to this question is interesting, and it highlights the ambivalence researchers, theorists, and practitioners in art and design sometimes exhibit concerning this issue:

Some of the women in this book would reply "No, of course not. The gender of the architect is quite irrelevant." While strongly maintaining that they should be judged by their architectural work, others would argue that the two sexes [genders] have fundamental differences of approach to design, and that women should recognize their own value in what is still predominantly a man's world, and use it consciously in the search for a more humane architecture.

That is a refreshing view. (p. 7)

While people working in art and design do not want to foreground gender as an evaluative concept, some do want to recognize and foreground differences they see related to gender in order to enact change in art and design practices.

Other researchers working in art and design have developed empirical investigations of gendered performance. Flannery and Watson (1995), for example, have investigated the role of gender in children's drawings. Flannery and Watson connect their research to a 15-year line of empirical investigations of
gender differences, primarily in children’s artwork, that suggests gender-based differences in subject matter, thematic choices, and expressiveness. Flannery and Watson conclude, based on their own study, that there are thematic and content differences in male and female children’s art. These conclusions were based on the rating of children’s artwork by male and female psychology undergraduates, who examined the artwork for aggression, fantasy themes, expressiveness, and artistic ability. Unlike other investigations of visual production performance, this study did not empirically verify the existence of certain items in the drawings, but relied on the perceptions of the raters. This will become important in discussing perceived gender differences below.

Cupchik, Winston, and Herz (1992) provide a different empirical examination of gender differences related to art. Their research focused on interpreting rather than producing artistic works. Cupchik, Winston, and Herz studied the ability of male and female undergraduates to determine similarities and differences between paired paintings. Females were found to be “less accurate [than males] at judging the stylistic quality of paintings that were indeed similar in style. . . . These findings suggest that females tend to be more deliberative and holistic than males in their interpretive styles” (p. 47). As with psychological studies of male and female visual abilities, this study seems to find performance differences tied to gender.

While the research is not as prevalent and much of it is anecdotal rather than empirical, gender studies in art and design generally seem to support the idea developed in psychology that there are gender-based performance differences in artistic ability, both in production and interpretation. In fact, at least some of this work draws on psychology for its method. Cupchik, Winston,
and Herz (1992), for example, note specifically that their research draws on experimental research of the nineteenth century (p. 38). This connection might indicate either or both of two things: that empirical research into gender differences was developed based on psychology findings concerning gender differences in visual ability or that art and design researchers have been interested in verifying or refuting anecdotal attributions of gender differences and have drawn upon psychology for methods to do so. Either way, the emphasis in this line of research in art and design is certainly focused on identifying gender-based performance differences.

**Gender and graphic presentation in professional communication**

Professional communication, when it has examined the issue of gender and graphics at all, has generally followed the lead of psychology, focusing on empirical examinations of performance differences between men and women. Some of the visual researchers—working in what I am considering here as professional communication—are, in fact, psychologists working in applied research. Other researchers are professional communicators working from a psychological research framework. Because of this connection between professional communication research and psychology, the focus has been on examining performance rather than perceptions of gender differences.

Togo and Hood (1992), two psychologists studying graphics in professional communication contexts, present a rationale for combining psychological studies of visual ability with discussions of visual communication and gender when they note that the findings of their study may reveal the "spatial or geometric element in the graphical presentation of quantitative information" (p. 165). Rough analogues can be drawn between the kinds of graphic materials that
professional communicators use and the kinds of visual ability that psychologists have found related to gender by using Linn and Petersen's (1985) meta-analysis categories, as shown in Table 2.1 (the task descriptions are adapted from Linn and Petersen).

Table 2.1 Correlation of psychological visual ability categories, tasks involved, and graphic techniques

<table>
<thead>
<tr>
<th>Psychological category</th>
<th>Tasks involved</th>
<th>Graphic technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>spatial perception</td>
<td>use of horizontal and vertical axes; ignoring distracting cues, frames, borders, etc.</td>
<td>graphs, charts (which use multiple axes), and grid/coordinate maps</td>
</tr>
<tr>
<td>mental rotation</td>
<td>ability to &quot;imagine&quot; various parts of object and their relationship to both the object and the self</td>
<td>diagrams, instructional photographs, and line drawings</td>
</tr>
<tr>
<td>spatial visualization</td>
<td>processing multi-step, analytical procedures using a variety of strategies</td>
<td>assembly instructions, very complex diagrams, and multi-dimensional charts (this category is sometimes placed with mental rotation)</td>
</tr>
</tbody>
</table>

Support for the connections I have drawn in Table 2.1 between perceptual psychology research and visual elements used in professional communication can be found in applied psychological research. For example, Tversky (1991) suggests a connection between spatial perception ability and graphs and maps in claiming that using both requires "segregation of figure from ground . . . and figure recognition. . . . Once isolated, figures are organized relative to one another and relative to a frame of reference" (p. 61). McConathy and Doyle (1991) provide a similar connection between mental rotation and diagrams and instructional photographs in their discussion of interactive displays in medical art. The first task for viewers of diagrams, especially of poorly prepared diagrams
with "little or no orienting landmarks," is "orientation . . . rather than the intended task of information processing" (p. 104-105). Grunwald (1991) makes a further connection between mental rotation, or tasks of mental orientation, to a relatively new area of visual design: "virtual environments and head-mounted displays" (p. 168). Virtual environments refer to screens used in computer simulations; head-mounted displays refers to graphic displays that show up on windshields or helmet visors, typically in airplanes. Understanding the connection between the visuals used in professional communication and the research performed in psychology establishes a level of justification for examining gender as an important variable in visuals in professional communication.

The discussion of gender as it might affect the production and reception of visuals has not received much attention within the context of professional communication. While some empirical studies suggest the possibility of gender differences in results, few go on to develop this in analyzing study results, and some do not even report the gender breakdown of their participants. For example, Bartram (1984), in his research in bus maps and timetables, cites a previous study of British children using timetables in which differences were found in male and female performance. However, Bartram gives no indication of the gender breakdown of the participants in his own study. Another example of ignoring potential gender differences can be found in Szlichcinsky's (1984) examination of line drawing techniques and user performance. Even though his study appears to have involved a great deal of mental rotation and orientation by the participants, the area of spatial ability that psychologists indicate might be the source of the largest difference in male and female
performance, Szlichcinsky does not report a gender breakdown of the results for the 1086 participants he tested. He notes that for 16 participants, gender was not even recorded. However, he does provide a breakdown or results based on age and occupation. This failure to examine gender is reminiscent of the phenomenon Richardson (1991) identifies among some psychologists:

Nevertheless, most researchers totally ignore gender as an important social variable . . . It may be omitted from the design of the original experiment, overlooked in the data analysis, or eliminated from the final report . . . Eichler . . . decried against such “gender insensitivity” as a profound methodological problem that was inherently sexist in its probable outcomes. (p. 273)

I have been able to identify three studies that focus specifically on gender and visuals in professional communication. By visuals in professional communication I mean visual elements commonly used in documents designed for work or functional communication. Two of these studies deal with the reception and interpretation of quantitative information presented in graphic form, while the third discusses the production of a process diagram. All three focus on actual performance rather than on the perception of gender differences. Peterson (1983) found gender-based effects in testing over 600 college seniors using a series of textbook passages containing narrative only, narrative with tables, narrative with graphs, and narrative with both graphs and tables. While reader retention and reader time were not affected by the different graphic presentations, reader reaction (positive vs. negative) was. Females preferred tabular formats and males preferred graphic formats. Togo and Hood (1992) examined differences in male and female performance on mathematics tests that
used various types of graphic presentations of quantitative information that were given to junior and senior business majors at a university. Togo and Hood found that there were significant differences in male and female performance depending upon the mode of graphic presentation. Female scores were lower than male scores when material was presented in graphic form (bar, line, pie, and comparative bar graphs), while male and female scores were equal when material was presented in a tabular format.

Bosley (1992) examined the effects of gender on the production of visuals. Bosley presented 128 students with a design prompt that required them to create a visual representation of a water purification process. She then analyzed the resulting diagrams for gendered design practices developed from her application of gender language theory and psychology studies of gender and visual ability to visual design. Bosley found no significant differences in male and female performance except in a tendency among females to use more rounded shapes and among males to use more angular shapes.

These three studies represent the work done in professional communication on gender and graphics to this point. All three focus on the effect of gender on the performance of the participants. They are all connected to psychology research on visual ability: Peterson (1983), by her reliance on behavioral psychology research design; Togo and Hood (1992), who are psychologists and who publish in psychology journals; and Bosley (1992), who relied on psychology research on gender and visual ability. Bosley, despite the fact that she does base a significant portion of her method on gender theory and research, does not examine issues of perception of gender differences, focusing, instead, on an examination of performance only.
Gender differences as a matter of perception

While work has been completed on gender and performance differences in visual communication in psychology, art and design, and professional communication, only the field of art and design has been concerned with the examination of perceived differences in male and female use of visual material. The work done in art and design concerns the socio-cultural, historical examination of the perception of gender characteristics in art and design practice. This research examines the role that perceived gender differences in design practice have played in the development and training of women in art and design related fields and in the recognition of women in art history. It is to this work that Freedman (1994) refers when she states that the “role of women in art and art education have [sic] been debated for generations” (p. 157). This socio-cultural and historical approach to the issue of perception and gender in art and design provides a great deal of useful information, but to this point, art and design researchers have not empirically examined the role of perceived gender differences in artistic production and interpretation.

Gender has often been used as a method for determining the kind of design practice and training a person engages in. Frost’s comment that women are more adept at detail and therefore are well-suited to working in residential design (Anderson, 1980), is one instance of this phenomenon. Monni Adams’ (1993) study of “women’s art as gender strategy among the Wè of Canton Boo” discusses how certain forms of artistic expression are specifically maintained within the sphere of female activity. In Canton Boo society (Canton Boo is a
region in sub-Saharan Africa), women are accorded very little power and authority. However, women are allowed control over the decorative arts: “Boo women apply abstract decoration to three kinds of surfaces: the walls of houses, the surfaces of pots, and the faces of girls. . . . Within an overarching ideology that men control both communal and household activities, these decorations mark domains managed by women” (p. 32).

The gender-based distinction identified by Adams is not limited to non-western tribal cultures. Cheryl Buckley (1989) discusses the manner in which gender has been used in Western culture to determine areas of design in which women are allowed to practice. Buckley notes that women designers . . . are tied to their biology by patriarchal ideology, which defines their skills as a product of their sex—as natural or innate. Women are considered to possess sex-specific skills that determine their design abilities; they are apparently dexterous, decorative, and meticulous. These skills mean that women are considered to be naturally suited to certain areas of design production, namely, the so-called decorative arts. (p. 253)

This is a much more critical view of the issue of gender and artistic ability/performance than that offered by perceptual psychologists. Buckley is concerned about the manner in which perceptions of differing abilities, rather than actual performance, are translated into restrictions influencing the appropriate areas of practice. Buckley’s (1994) analysis of early twentieth century pottery designer Susie Cooper provides an example of how perceptions of gender-based difference are treated as actual performance differences. Cooper was praised for “designs . . . which were ‘feminine.’ . . . the subtle colour ranges,
delicate, light decoration, and shapes which were . . . understated and stylish" (p. 285). Male designers of the same period, creating very similar styles, were not described in any of these terms.

Other analyses of art history and art education have arrived at conclusions similar to Buckley’s. Collins (1994), an award-winning art educator, suggests a similar line of reasoning in her praise of feminist theory in art education. Collins argues that feminist research has allowed the examination of “the devaluation of women-associated art forms, subject matter, and career patterns” (p. 73). It is important to note that Collins identifies these areas as women-associated, which focuses attention on perceptions rather than on actual performance. Collins increases the emphasis on perception when she critiques “images, ideas, and narratives that reinforce negative stereotypes of women, which in turn are used to justify further differences in treatment” (p. 71).

The discussion of perceived gender differences in art and design shows the difficulty of maintaining strict divisions between performance- and perception-oriented research. For example, Garber (1992) in her discussion of feminist aesthetics, quotes Gisela Ecker (1985) as arguing for “genderising” investigations of art. Genderising would mean “that the gender of makers and viewers be considered a factor influencing their opinions, perceptions, and general understandings” (p. 210). Considering gender as such a pervasive influence, however, quickly leads to seeing performance differences, as Lippard (1976) does, arguing that women’s art often contains a “central focus (often ‘empty,’ often circular or oval), parabolic baglike forms, obsessive line and detail, veiled strata,” as well as a number of other characteristics (quoted by Garber, p. 211-212). Joann Waugh, also cited by Garber, argues that these female performance characteristics
simply reinforce "characteristics socially assigned to the sexes and perpetuates a dichotomy of differences. . . . Associations that reinforce traditionally feminine qualities define and circumscribe what and who women can be" (Garber, p. 212).

In the discussion of perceived gender differences in art and design, the separation between performance and perception can become muddled. If women are perceived as possessing certain characteristics and are then trained accordingly, there seems some logic in the idea that eventually they possess certain performance characteristics. On the other hand, if perceptions are based on mistaken notions of performance, women's visual production may be perceived as possessing characteristics that it does not necessarily have. It becomes important, then, to develop methods to determine not only what male and female performance characteristics are, but also what perceptions people have of male and female performance. Unfortunately, art and design researchers have not pursued empirical examinations of perceived gender differences in artistic practice. When perceptions are used, they are taken as indicators of elements actually occurring in the artwork itself. The Flannery and Watson (1995) study discussed above is a good example of this phenomenon. They used evaluators' perceptions of the drawings to determine whether the male and female artists exhibited actual performance differences; however, these perceptions were apparently not subjected to any systematic empirical examination. This approach to performance differences further muddles the performance/perception distinction. A more systematic approach to identifying and testing perceived differences seems necessary to fully understand how perceived gender differences might affect evaluations of visual designs.
The need to examine performance and perception together

The research in psychology, art and design, and professional communication on gender and its potential or actual effects on visual performance is interesting and useful. As Peterson (1983) suggests, this research might allow us to determine how best to develop visual elements in documents for various audiences. Work with perceived differences in art and design, however, suggests a slightly different focus, examining how the perception of gender differences might affect the performance, training, and participation of men and women in visual design. This perception focus would allow us not only to determine what visual presentations might be most effective, but also why some visual presentations seem more effective for some groups and not others as well as why some visual presentations are created in different ways by different people. However, none of the research done in psychology, art and design, and professional communication provides any method to work toward resolving the apparent conflict between those who see gender as affecting performance and those who see it affecting the perception of performance. What is needed is a research method that allows both issues to be dealt with in one examination, in the same way as the communication research Booth-Butterfield (1993) calls for would investigate “communication behaviors and subsequent reaction to the behaviors” (p. 380).

In the following chapter, I describe a method developed to respond to this issue, a method that simultaneously explores the perception of gender differences and analyzes whether gender differences exist in performance. The study uses process diagrams created by a group of undergraduate students and
evaluated by graduate students from a variety of disciplines. I use the diagrams and the evaluations to answer five specific questions:

1. Can raters of a process diagram make consistent and accurate determinations of the gender of the diagram’s designer?
2. On what basis do raters make their determinations of a designer’s gender?
3. Can the traits used for gender determinations be quantified in the diagrams and positively correlated with the self-reported gender of the designers?
4. Do the traits identified by the raters correlate with the raters’ own gender identifications?
5. How do determinations of gender correlate with other evaluations of the diagrams, such as effectiveness, visual appeal, or designer knowledge?

Questions 1, 2, and 5 deal primarily with the issue of gender perception, how gender is perceived in visual designs and the effect gender perceptions have on the ways people interpret or evaluate the designs. Question 3 deals specifically with the issue of performance differences and gender, but does so in the context of the perception questions. Question 4 provides for a combination of both performance and perception issues.
CHAPTER 3

DESIGNING A STUDY OF GENDER-BASED PERFORMANCE AND PERCEPTION DIFFERENCES IN VISUAL COMMUNICATION

To begin exploring the larger issue of how gender might affect the creation and perception of visuals in professional documents and to answer my five research questions, I designed a study using a set of process diagrams created by students enrolled in a technical communication course at Iowa State University. After collecting the diagrams, I used them to perform three different procedures, two of which involved "lay raters," people without specific professional communication expertise, and one of which involved my own textual analysis of the diagrams.

1. The lay raters were shown a group of diagrams and asked to complete a questionnaire about the diagrams.
2. The lay raters were interviewed about their questionnaire responses.
3. Based on the raters' interview responses, I performed an analysis of specific quantifiable elements of the diagrams.

Portions of each of these procedures provide answers to one or more of the research questions. Table 3.1 equates each research question with the portions of my study that respond to it.

This research design distinguishes my study from Bosley's (1993), which I replicate in some ways (the use of students as designers, the use of a process

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1 The research methodology described here was approved by the Iowa State University Human Subjects Review Committee.
Table 3.1 Alignment of research questions with portions of the analytical procedures

<table>
<thead>
<tr>
<th>Research question</th>
<th>Procedure(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Can raters of a process diagram make consistent and accurate determinations of the gender of the diagram’s designer?</td>
<td>Lay rater questionnaires</td>
</tr>
<tr>
<td>2. On what basis do raters make their determinations of designer gender?</td>
<td>Lay rater interviews</td>
</tr>
<tr>
<td>3. Can the traits used for gender determinations be quantified in the diagrams and positively correlated with the self-reported gender of the designers?</td>
<td>Quantitative analysis of diagrams</td>
</tr>
<tr>
<td>4. Do the traits identified by the raters correlate with the raters’ own gender identifications?</td>
<td>Quantitative analysis</td>
</tr>
<tr>
<td></td>
<td>Lay rater questionnaires</td>
</tr>
<tr>
<td>5. How do determinations of gender correlate with other evaluations of the diagrams, such as effectiveness, visual appeal, or designer knowledge?</td>
<td>Lay rater questionnaires</td>
</tr>
</tbody>
</table>

Diagram). Where Bosley began with a set of criteria established in gender theory literature and found no significant differences, I attempted to allow raters of the diagrams to determine whether male- and female-designed diagrams appeared to differ and then to establish the criteria on which differences might be based. My research design also differs from other empirical research in both psychology and art and design in that it combines the issues of performance and perception differences.

Collecting student-designed diagrams

To examine the possible effects of gender on a process diagram, I needed to collect a number of diagrams created for the same situation and based upon the
same topic, but by a variety of men and women. For this study, I collected 22 diagrams of the sunflowerseed oil extraction process created by undergraduate students in two sections of a technical communication (English 314) course at Iowa State University. One portion of the study required that I modify the student-designed diagrams.

Because the type of communication situation needed for this study, a situation in which a number of people prepare diagrams in response to the exact same situation, is at best rare in the workplace, it seemed necessary to use students, who could all be given the same design prompt at the same time. In addition, student designers seemed most useful for me because professional communication pedagogy is an important focus of my study. Unlike Bosley (1992), who used first-year college students in an effort to deal with a population "who had not been taught to construct visuals since training may level off any gender differences in verbal and spatial abilities" (p. 225), I used advanced undergraduates for precisely the opposite reason: if significant differences between male and female designers persisted despite similarities in training and education, the differences might be seen as more powerful.

The initial group of participants in this stage consisted of 43 students—13 female, 30 male—who were enrolled in two sections of English 314, Technical Communication, at Iowa State University. I was the instructor for both sections. Of the 43 students, 42 were enrolled in technical majors ranging from biomedical engineering to landscape architecture, from computer engineering to chemistry. One female student was enrolled in a non-technical major: English with an emphasis in professional and technical communication.
Students were given the option of declining to participate in the study. All students who chose to participate completed a “Participant Release Form” indicating willingness to participate and giving permission to use their materials. Student participants were told that their diagrams would be used for my dissertation research, but they were not told that gender was part of the research question until all portions of the procedure were completed.

Before analysis, the group of 43 student-designed diagrams was narrowed to a collection of 22. Of the 43 students asked to complete the diagrams, 39 (27 males and 12 females) completed all portions of the study including the release forms allowing their materials to be used. Some of the students who did not sign release forms were absent on the day the forms were distributed. Other students either forgot to or chose not to sign the forms. (To protect the right of students to decline participation, I did not keep track of who chose not to participate and who simply neglected to sign the release form.) Numbers were assigned to each student’s set of documents to preserve anonymity during the analysis and reporting phases of the study.

Of the 39 documents created by participants (27 males and 12 females) who signed release forms, 4 male-authored diagrams were removed because the authors were English as a Foreign Language (EFL) students. EFL status seemed to be a potentially important confounding factor in the study, both because it might hamper understanding of the design prompt and because cultural differences might cloud gender issues. One female-authored document was removed because the author had created an entire brochure rather than just the diagram asked for in the writing prompt. Using that diagram would require an explanation for the raters that might affect their perceptions of the document.
Since the analytical procedures required a balanced sample of male- and female-designed diagrams, I used a stratified random sample of male-designed diagrams. All male-designed diagrams were placed in random order and numbered from 1 to 27. Then, 11 numbers were drawn at random. These 11 male-designed documents were paired with the 11 female-designed documents. This gave me a group of 22 diagrams for use in the analysis stage. All identifying information, including the prewriting and the questionnaire each designer completed, was separated from the diagrams of the oil extraction process before they were used for analysis.

Document creation

Participants were asked to complete three steps for this study. (The verbal instructions given to students for completing all three steps are in Appendix A.) The three steps were carried out during two regularly scheduled class meetings (a total of 90 class minutes). Steps one and two were completed on the first day of the study, while step three and the signing of the release form were completed on the second day (two days later). These class meetings preceded any classroom instruction or assigned textbook reading in creating or using visual designs in professional documents. The study was given at this point in the semester to avoid any influence from material the students might receive in class that would lead to more homogenous results.

Step one: Written description

Write a description of everything you know about the sunflowerseed oil extraction process. The students were allowed five minutes to freewrite whatever they knew or thought they might know about the process. This initial
prewriting activity, as well as some of the information requested from the students in step three, was designed to elicit differences in students' prior knowledge about the extraction process. All of the students stopped writing before the five minutes expired. With only one exception, the students indicated that they knew little or nothing about the process prior to reading the prompt described in step two.

**Step two: Visual diagram**

*Read a description of the sunflowerseed oil extraction process and draw a diagram of that process.* Students were told that the diagram they designed was to be included in a brochure for the general public. The brochure would be distributed at a display on sunflowerseeds in the University’s new Food Sciences building. (The writing prompt for this step is in Appendix B.) This sunflowerseed oil extraction process description was taken from *Technical Communication, 3rd ed.*, a widely-adopted undergraduate-level technical writing textbook by Rebecca Burnett. This prompt was selected because it represented a task designed to be given to students like those in this study. In addition, it is a thorough, well-written description of the sunflowerseed oil extraction process. The process was taken from a U.S. Department of Agriculture document, *The U.S. Sunflower Industry*. As such, it appears to have been written for an educated, but not necessarily technical, audience. While it contains some vocabulary that might be unfamiliar to some of the students, the description should be generally understandable for all of them. This prompt also seemed appropriate because it provided ample opportunities for both visual and textual adaptation. The process consisted of distinct stages that could be visually enunciated, a number of mechanical instruments were identified that could be
drawn either realistically or symbolically, and the process was sufficiently complex that students would be able to produce very different visual portrayals. These elements seemed to make this description of the sunflowerseed oil extraction process ideal for the design prompt for this study.

The precise task, creating a visual diagram of a technical process for a general audience, was developed to represent a task often faced by people working in technical fields. The task seemed relevant to the kinds of designing that technical professionals might be asked to complete: taking a complex textual description of a process and translating it into a visual description that would allow people to better understand it. In addition, having a concrete situation for which to create the diagram would aid the students in making decisions about what to include and what to exclude from the original written description. Establishing a specific situation for all of the designers would also allow for better analysis, since the explicit purpose of each of the visuals would be established.

Students were given approximately 40 minutes to complete their diagrams. Most students finished in approximately 20 minutes, while a few took between 30 and 40 minutes. No students indicated having any difficulties completing the task in the given time frame. Allowing students ample time to complete the task was important given the psychology research that identifies timed environments as a factor in decreasing female performance on visual tasks. Although the students completed the diagrams in a classroom equipped with computers, they drew the diagrams by hand to avoid complications arising from different skill levels with the computers and available software. (The student-generated diagrams are in Appendix C.)
Step three: Demographic questionnaire

Complete a questionnaire that contained questions concerning participant demographics (age, major, gender, etc.), prior knowledge about the sunflowerseed oil extraction process, and prior experience with process diagrams. (A copy of the questionnaire is in Appendix D.) Demographic information was necessary in order to establish the self-reported gender and academic major of the participants. I requested more information than was actually required for the study (age, for example) in an effort to decrease the attention paid to the information that was necessary (gender), thus diminishing the possibility that participants might guess the actual focus of the study. Unlike the freewriting activity, which allowed students to write anything they knew about the process, the questionnaire asked specific questions about their prior knowledge. I attempted to establish the prior knowledge of the participants because I believe that prior knowledge plays a role in the way material is selected for inclusion in the diagrams. As indicated above, however, the students as a group seemed to feel that they had little knowledge of the process prior to reading the description I gave them. Only one student indicated any knowledge of the sunflowerseed oil extraction process. Since the prior knowledge information did not reveal any differences between the vast majority of students, only the demographic portion of the questionnaire and the diagram created in step two were used for this study.

Document modification

During the first lay rater evaluation procedure, the handwriting of the student-designers became an important method for the raters in identifying the gender of the diagram authors. For this reason, a second round of evaluations was completed using modifications of the original diagrams used in the
evaluation stage. Each of the diagrams used in the study was scanned using a Macintosh® computer and Adobe Photoshop® software. The original handwritten text was deleted and replaced with text typed in Geneva typeface in a point size that matched the size of the original text. This typed text was placed as closely as possible to the location of the original text. A standard sans serif typeface was used to avoid creating any kind of effect based on the possible gender stereotyping of typefaces. Geneva was selected because it is used in a variety of technical documents and so would seem fitting given the context of the diagram.

The modified diagrams, with the typed text, were printed on white paper. (The modified versions of the student diagrams are in Appendix E.) A random selection of 11 of the modified diagrams (50%) was examined by two of my colleagues in the ISU Rhetoric and Professional Communication doctoral program to ensure that I had not introduced any spelling or typographical errors not contained in the original and to ensure that the overall integrity of the original diagrams was maintained throughout the modification. The modified versions of the diagrams were used with the second group of lay raters; the raters in the second group were given a description of the modification process although they were told the modifications were made to ensure the legibility of the text. (A copy of the modified instructions provided to Group 2 raters is provided in Appendix F.)

Evaluating the student-designed diagrams

To answer the five research questions established above, I used the 22 student-designed diagrams in four evaluative procedures. To highlight the
connection among the research questions and the procedures, I have organized the following discussion around the five research questions.

**Can raters of a process diagram make consistent and accurate determinations of the gender of the diagram's designer?**

To answer the first question, whether raters can make consistent and accurate gender identifications of the diagram designers, I presented the 22 student-designed process diagrams, selected as described above, to two groups of raters. Each group consisted of 12 raters from a variety of disciplines, each of whom was completing or had completed at least a master’s degree in her/his discipline. I wanted the raters to represent a variety of training and experiences. Therefore, I used graduate students because they have more equal and more developed disciplinary-specific training, but I selected graduate students from a variety of disciplines to insure that no particular discipline would have an overwhelming influence on the results. The first group examined the original diagrams created by the students. The second group examined the modified versions of the originals.

*Lay raters—Group 1*

The 12 raters who evaluated the original diagrams were graduate students who were in the process of completing or had already completed at least a Master’s degree in their discipline. All 12 raters were volunteers. Raters in Group 1 came from six different disciplines:

- chemistry
- engineering

2 Whenever individual raters are referred to, raters from Group 1 are identified by the numbers 1 through 12 and raters from Group 2 are identified by the letters A through L. This system of reference is designed to prevent confusion over which group individual raters belong to.
• agronomy
• genetics
• journalism and mass communication
• human development and family studies

From each of these disciplines, I had one male and one female rater. Initially, I selected 6 raters, all of whom were acquaintances or colleagues of mine. I then asked these 6 individuals to provide me with names of people who were in roughly equivalent places in their degree programs who might also be willing to participate as raters. I selected the 6 additional raters from the names given me by the initial 6. I used this method to facilitate matching raters by degree program, degree status, and gender. (Complete descriptions of raters from both Group 1 and Group 2 are provided in Appendix G.)

Rating questionnaire

Each rater was asked to complete a five-item questionnaire for each of the 22 diagrams. The five questions were separated into two categories: questions about the author of the diagram (items 1-3) and questions about the diagram itself (items 4 and 5). The five questions consisted of the following:

1. This author’s major is: Technical_____ Non-technical_____
2. This author is a/an: Undergraduate_____ Graduate_____
3. This author is: Male_____ Female_____ 
4. How visually appealing is this design?
5. How effective is this design?

Each of the first three items asked the rater to select one of two possible responses, and then to mark her/his “certainty” about the selection on a five-point Likert scale. Items 4 and 5 asked the rater to mark her/his evaluation on a
five-point Likert scale. Item 2 on the questionnaire, the question about the
diagram author’s education level, was designed as a distracter to decrease
emphasis on the question of the author’s gender (item 3) which was the primary
focus of this study; item 2 was not used in any of the data analysis. (Instructions
given to Group 1 raters are in Appendix H; the questionnaire is in Appendix I.)

The certainty rating was used for item 3 to allow the raters to register
doubts or ambiguities about the gender of the diagram designers. I chose this
method over alternative designs, such as providing a continuous scale (as used
for items 4 and 5) or other terms, such as “androgynous” or “undifferentiated.”
These alternatives appeared to highlight the gender question in a way that would
diminish the usefulness of the study. Using a continuous scale or terms such as
“androgynous” or “undifferentiated” might require an explanation that a
“certainty” rating would not; the explanation might heighten awareness of
gender as the raters examined the diagrams. In addition, because gender is not
commonly thought of as resting on a continuum, such a scale might distract
raters from evaluating the diagrams. Using the term “androgynous” brings an
additional difficulty: androgyny is not a common concept in gender
identification (and might carry unnecessary negative connotations rather than
being seen as a neutral or intermediate term). Certainty ratings allowed me to
compile “gender scores” that indicated when a diagram’s designer might have
been perceived by raters as androgynous or undifferentiated. The tabulation of
these gender scores is described in detail below.

Raters were asked to complete the entire questionnaire for one diagram
before proceeding to the next diagram in an effort to reduce direct comparisons
between diagrams. As the raters completed the questionnaires, I took notes to
identify patterns about how the raters went about reading the diagrams or answering the questions or aspects of the rater's answers that seemed interesting or unusual. I also noted any comments the rater made while examining the diagrams or questions they asked me as well as my responses. Finally, after completing the first of the rater sessions, I made comparative notes on items I had on previous raters.

**Lay raters—Group 2**

As described above, I modified the diagrams to remove all handwritten text based on my initial analysis of the results of the ratings of the first group of lay raters. I then replicated the rating procedure described above, this time using the modified diagrams, with a second group of 12 raters. (See Appendix G for a description of both Group 1 and Group 2 raters.) I selected these raters based on the recommendations of raters in the first group as well as advisors and professors in various departments at Iowa State. In selecting raters, I matched the academic disciplines of raters used in the first group to control for academic background and training. I also paired raters in the second group on the basis of gender and program/degree status as I did the raters in the first group.

**Statistical analysis of lay rater responses**

To answer research question 1—Can the evaluators of a process diagram consistently and accurately determine the gender of the designer?—I completed a chi-square analysis of the raters' responses to questionnaire item 3. First, I tabulated the raters' responses to item 3, concerning the designer's gender, by counting the number of male and female identifications. Certainty ratings were tabulated with a + or - sign, indicating whether the rating was certain (a + for
certainty ratings of 3 or higher on the 5-point scale) or uncertain (a - for certainty ratings of 2 or lower). Second, I performed the chi-square analysis to determine whether the gender perception ratings were merely random, whether their accuracy (or lack thereof) occurred by chance. I placed the raters’ gender identifications as one variable and the self-reported gender of the designers as the other in a 2X2 chi-square. Chi-square analysis allowed me to determine whether the connection between the self-reported gender and the perceived gender of the diagram designers occurred randomly or if there were some apparent relationship between the two. This chi-square analysis was completed separately for the ratings of both groups of lay raters.

In addition to completing the chi square analysis, I developed a “gender score” for each design based upon the responses of raters in each group. The gender score assigned numerical values to the gender ratings. A “M+” rating was assigned a -2, a “M-” rating a -1, a “F-” rating a 1, and a “F+” rating a 2. These numerical ratings were then multiplied by the number of raters in each group who selected that response. An overall positive gender score indicates that more raters identified the designer’s gender as female and an overall negative gender score means more raters identified the designer’s gender as male. These numerical gender scores allowed me to complete Pearson product moment correlations between the gender ratings and other quantifiable aspects of the designs and the raters’ responses.

The gender scores also allow the gender identifications to be placed on a continuum, with strong male identifications being at one end (-24 for each group), strong female at the other end (24 for each group), and “androgynous” or “undifferentiated” in the middle (0 for each group). Androgynous scores in this
system would be indicated by either strong but conflicting identifications (half
the raters giving strong male ratings, the other half strong female) or an even
mixture of ratings across the continuum (2 or 3 in each category).
Undifferentiated scores would be indicated by a clumping of ratings in the
middle (6 in "M-" and 6 in "F-"). The continuum could be further marked off
with an androgynous or undifferentiated zone in the numerical center of the
score continuum, using 8 and -8 as the end points.
Finally, I used the gender scores to answer a secondary research question
that developed in the analysis: Does access to designer handwriting make raters’
gender identifications more accurate? To answer this question, I identified
whether the gender scores represented an accurate perception of the designer’s
gender for each group as a whole. In order to be accurate, a gender score for a
male designer had to be above 8 or for a female designer below -8 (with 8 and -8
serving as ends of the androgynous or undifferentiated scores as described
above). Once I had determined the number of accurate and inaccurate scores for
each group, I compared the two groups’ responses using a chi-square. This
allowed me to determine the statistical significance of handwriting as a factor in
the accuracy of the raters’ gender identifications.

On what basis do raters make their determinations of designer gender?

Examining whether raters could determine the gender of diagram
designers is an interesting and useful task. However, the more important
questions involve the basis on which raters make these determinations, whether
the determinations are idiosyncratic or occur in identifiable patterns, whether
they are based on socially held stereotypes or on specific elements of the
diagrams, and whether the traits raters use to make these determinations can be
empirically identified or quantified in the diagrams. The answer to these questions might allow the results of this study to be extended to other types of visual designs as well as to connect this study to the other discussions of gender in language, psychology, and art and design.

To answer this second research question, I interviewed the raters immediately after they completed the questionnaires for the diagrams as described above. In addition, after completing the interviews, I used the traits identified by the raters to analyze each of the 22 diagrams used in the study.

*Stimulated recall interviews*

Immediately after the raters had completed questionnaires for all 22 documents, I interviewed them about their reactions and their questionnaire answers. The interviews consisted of first looking at a diagram and the rater’s questionnaire responses to that diagram. The rater would then explain her/his rationale for each of the responses, and I would ask follow-up questions based both on their oral rationale and on the notes I took during the rating process.

Each interview consisted of a discussion of 6 diagrams. I randomly selected 3 of the diagrams for discussion prior to meeting with any of the raters. All 12 raters were asked about those 3 diagrams. Based on my notes of each rater’s rating process, I also selected 3 other diagrams to examine during the interview. These diagrams were selected based on the rater’s reaction to them during the questionnaire period. I selected documents for which the rater exhibited a reaction that I thought was interesting or unusual. For example, I selected documents in which raters laughed while examining them, marked the questionnaires unusually quickly or slowly, changed ratings, made verbal
comments, or marked what I thought were contradictory selections on the questionnaires. I took notes of everything said by the rater during the interview. (Appendix J contains tables showing the diagrams each rater was questioned about in the interview.)

**Determining frequency of identified traits**

Once the interviews were completed, I analyzed my notes of the raters' responses for patterns of traits used to make the five ratings asked for on the questionnaire. I identified how many times particular traits were mentioned as explanations for a particular rating. For example, handwriting was mentioned by a number of raters as one trait for determining gender. In my analysis of the interviews, I counted the number of times handwriting was mentioned as well as the number of raters who mentioned handwriting at least once. I then ranked the responses I had identified by frequency. I used this ranked list to determine which traits I would use for my own empirical analysis of the documents.

**Can the traits used for gender determinations be quantified in the diagrams and positively correlated with the self-reported gender of the designers?**

Once I had identified the traits that raters believed they were using to identify gender, I attempted to answer the next question: Can the traits used for gender determinations be quantified in the diagrams and correlated with the self-reported gender of the designers? In order to answer this question, I analyzed the diagrams using the traits mentioned most often by the largest number of raters. These traits consisted of

1. use of “male” vs. “female” handwriting
2. number of words used in the diagrams
3. number of visual items used in the diagrams
4. difference in types of visual items
5. use of angles versus rounded corners

Each of these traits was compared to the self-reported gender of the diagram designers to determine whether there were statistical differences for these traits in male and female designed diagrams.

**Male vs. female handwriting**

Based on the raters' perceptions of the diagrams, I identified the traits shown in Table 3.2 as belonging to what were described as "male" and "female" handwriting. I used what were identified as examples of male and female handwriting on various diagrams to further refine these two categories. I developed these trait lists in order to provide a "writing gender score" for each diagram.

The following traits were identified as male:

1. Smaller than 14-point helvetica
2. Used upper-case letters, including mixing large and small caps, for more than 50 percent of the text
3. Included erasures that were identifiable, words that were crossed or scribbled out rather than erased, or more than three words that were illegible
4. Shaped letters using angles on descenders or ascenders or on points at which lines intersected

---

3 Point size was determined using a point-size ruler. Point size is a printing industry standard for measuring the size of individual textual elements. The point-size ruler I used is made of transparent plastic with various sizes of the capital letter E in helvetica type-face. To determine point size, I placed this ruler over the diagram text and matched the handwritten text to one of the E's. This procedure allowed for rapid, accurate, and consistent point-size determinations.
Table 3.2 Male and female handwriting traits as identified by lay raters

<table>
<thead>
<tr>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>Large</td>
</tr>
<tr>
<td>All upper case</td>
<td>Mixed upper and lower case</td>
</tr>
<tr>
<td>Messy</td>
<td>Neat</td>
</tr>
<tr>
<td>Angular</td>
<td>Rounded</td>
</tr>
<tr>
<td>Printed</td>
<td>Cursive</td>
</tr>
</tbody>
</table>

5. Text included only print with no cursive writing

Figure 3.1 provides an example of these traits as they appeared in text from diagram 22.

The following five traits were identified as female:

1. Larger than 14-point helvetica
2. Used mixed-case letters for more than 50 percent of the text
3. Included faint erasures, no words that were crossed or scribbled out, and three or fewer illegible words
4. Shaped letters using rounded ends on descenders and ascenders or on points at which lines intersected
5. Text included cursive writing

Figure 3.2 provides an example of these female traits as they appeared in diagram 7.

I used these two sets of criteria to analyze each of the 22 diagrams that had been submitted to the lay raters. I created a “writing gender score” similar to
the gender score described above. Each of the five traits as identified in a diagram was given a numerical value: -1 for male traits, 1 for female traits, 0 for neither male nor female traits (for example, using lower-case letters only was not identified by the raters as being a male or female trait). I then totaled the trait

Figure 3.1 Example of "male" handwriting traits, from diagram 22

Figure 3.2 Example of "female" handwriting traits, from diagram 7
scores for each diagram, resulting in a writing gender score ranging from -5 to 5. I completed a t-test analysis using these writing gender scores to determine whether male and female designers used these writing traits differently.

**Word counts**

The second item for analysis was the number of words used in each diagram. Raters had suggested that there were differences in the ratio of words and pictures used in male- and female-designed diagrams. To determine the accuracy of this trait as an identifier of gender, I counted the number of words used in each visual. In instances in which what was a word and what was not might be unclear, I based my decisions on the following five criteria:

1. An abbreviation counts as one word.
2. Symbols for words (examples: & w/) count as one word.
3. Numbers count as words except when used to designate steps, stages, or pagination.
4. Numeric groups (examples: 502; 1,115) count as one word.
5. Chemical symbols that appear to designate a single chemical compound (example: C₆N₃+CO₂) count as one word.

I had two colleagues perform word counts on six of the diagrams, with a resulting interrater reliability of 97%. I used an independent t-test to determine whether there was a statistically significant difference between the number of words used in male-designed diagrams versus female-designed diagrams.

**Number of visual items**

Raters indicated that female-designed diagrams had a tendency to be more “picture-oriented,” to use pictures rather than or along with words to explain or
describe the oil extraction process. To verify the existence of this trait, I counted
the number of visual items used in each diagram. The difficulty of this analysis
involved distinguishing between visual elements, determining the separation
point between visuals that might be physically joined or juxtaposed in the
diagram. To separate the visual elements, I identified each element that seemed
to provide a functionally new object or concept in a verbal description of the
diagram. For example, if a diagram contained a picture of "seeds on a conveyor
belt," I counted the group of seeds as one object and the conveyor belt as a
separate object. If something was done to both the seeds and conveyor belt—for
example if the combination of seeds and conveyor belt were shown from two
different angles indicating that the seeds and conveyor belt were being treated as
a single object—I counted them as one object. This count of visual items was
independently tested by a colleague in my PhD program to determine inter-rater
reliability. I conducted an independent t-test to determine whether males and
females used different numbers of visual items in creating their diagrams.

Types of visual items

Many of the lay raters indicated that there was a difference not only in the
number of pictures, but also in the kinds of pictures used by male and female
designers. Testing these criteria required a method for distinguishing between
types and functions of pictures and other visual items. Some diagrams seemed
to use visual items that were representational in nature, while others used
visual items that seemed to be more iconographic and conventional. Some
diagrams used combinations of the two. I used Killingsworth and Gilbertson's
(1992) distinctions among an icon, an index, and a symbol in an attempt to
quantify the various kinds of visual items used in the diagrams. Because
Killingsworth and Gilbertson's "iconic" category lacks a method for distinguishing between different types of iconic objects, I also added a "replica" category.

Killingsworth and Gilbertson (1992) base their use of the terms "icon," "index," and "symbol" on the work of C.S. Peirce. According to Peirce, an object is

- iconic when it represents its object "mainly by its similarity" to that object,
- indexical when its primary function is to locate other signs or objects,
- symbolic when its main function is to give meaning to its object through an arbitrary conventional relationship. (Killingsworth and Gilbertson, p. 52)

For Killingsworth and Gilbertson (1992), however, a proper understanding of these terms as categorizing devices requires the recognition that they are based upon the function of particular visual items within a particular text. Killingsworth and Gilbertson (1992) argue that "an individual textual element may, depending on the context, function in a variety of ways" (p. 53). I chose to use Killingsworth and Gilbertson's (1992) categories precisely because they rely on contextual function. Rather than suggesting that an arrow, for example, always serves as an index, this method allows me to determine how the arrow functions in an individual diagram. This functional analysis places emphasis on "the process of meaning-making, interpretation" (Killingsworth and Gilbertson, 1992, p. 53). Since my study is interested in perceptions, a framework that emphasizes interpretation seems most useful. In using icon, index, and symbol, then, to analyze the diagrams, I am attempting to determine the function of each of the
visual elements identified in the "visual item count" described above in terms of its relationship to the diagramming situation and text.

Killingsworth and Gilbertson’s (1992) categories are insufficient in one regard: the iconic category does not distinguish between icons that seem to function as detailed attempts at realistic portrayals of actual objects versus icons that are more abstract representations of those objects. Such a distinction between iconic elements can be found in the work of other theorists. Ashwin (1984), for example, draws distinctions between types of figures based on their relative levels of specificity. The more concrete and specific a designer makes a sign, the less room there is for interpretation by the viewer of the sign.

Kostelnick’s (1988) “12-cell schema of visual communication” includes a cell that draws distinctions based on “resolution of details on images, abstract to realistic” (p. 33). And Arnheim (1969) distinguishes between stylized objects and replicas based on the level of abstraction present. Thus, I have divided Killingsworth and Gilbertson’s (1992) iconic category into two: iconic replica and iconic stylized, drawing on Arnheim’s terminology. Through the remainder of this dissertation, I refer to these two categories simply as replica and stylized. This provided me with four analytical categories: replica, stylized, indexical, and symbolic. Figures 3.3, 3.4, 3.5, and 3.6 show examples, all taken from diagram 15, of each type of visual item.

Once I had counted the number of replica, stylized, indexical, and symbolic images in each diagram, I then correlated the number of each with the self-reported gender of the diagram designers. I used a point biserial correlation analysis to determine whether the number of each type of visual items designers
Figure 3.3 Example of visual elements identified as "replicas." Both the bucket and the basket appear drawn to highlight similarities to actual objects.

Figure 3.4 Example of visual elements identified as "stylized." The fire representing heat and the line and circles representing the conveyor belt are both abstract representations of actual objects.

Figure 3.5 Example of visual elements identified as "indexical." The frame around the words and the arrow pointing to the next frame orient the reader.
used was correlated with the self-reported gender of the designers. This allowed me to compare male and female preferences in using each of the three types of visual items.

**Angled versus rounded corners**

Raters indicated that male and female designers differed in their use of angles on corners of objects in their diagrams. Bosley (1992) also examined the use of angles and rounded corners in her examination of process diagrams. A major difficulty in counting the number of angled corners versus the number of rounded corners used in visual items lies in determining whether the items are meant to be representations of an actual object that might possess, in reality, angled or rounded corners. Representational visual items would seem to eliminate some sense of designer preference in terms of selecting rounded versus angled corners. Unfortunately, Bosley (1992) does not discuss this issue and so provides no help in separating attempts at similarity or representation from designer preference for one type of corner. Having already distinguished between representational images and other types...
of visual items in the count of visual types (described above), I was able to make some distinctions that were useful.

To count the use of angled versus rounded corners in a way that revealed designer preference rather than attempts at realistic drawings, I eliminated all items labeled as "replica," meaning they attempted to be relatively realistic depictions of the objects they were portraying. This resolved the difficulty of determining designer preference as discussed above. The remaining items, those labeled "indexical" or "symbolic," were then examined. I counted each instance of rounded and angled corners within those items. For items that contained multiple corners, I counted each corner separately. For example, a box had four possible corners, which could be in any combination of rounded or angled. To determine whether a corner was angled or rounded, I simply measured whether the intersecting lines in a corner formed sharp angles; if not, I considered the corner to be rounded. (Figure 3.7 contains an example of both angled and rounded corners.) I then created percentages, dividing the number of angled corners by the total of all corners in each diagram, to allow comparisons between diagrams and between male and female designers. To determine whether male and female designers used different percentages of angled corners, I conducted an independent t-test using logarithmic transformations of the angled corner percentages. (The logarithmic transformation is required whenever percentages rather than integers are used.)

To test the reliability of my angled and rounded corner counts, I had a colleague from the Iowa State RPC program identify and count angled and rounded corners in 5 randomly selected diagrams (approximately 25 percent of the total number of documents).
Figure 3.7 Example of three angled and one rounded corners, from diagram 19

Do the traits identified by the raters correlate with the raters' own gender identifications?

The analysis of the diagrams indicated that the raters were inaccurate in some of the traits they believed were being used differently by male and female designers. As a result, I attempted to answer another question: Do the traits identified by the raters correlate with the raters' own gender identifications? Since I had already calculated the appearance of each of the five traits in the diagrams, answering this question was relatively easy and straightforward. I completed a Pearson product-moment correlation analysis comparing the gender scores with the writing gender score, word count, image-to-word ratio, and angled corner percentage. This analysis allowed me to determine whether any or all of these traits actually correlated with the raters' gender identifications.
How do determinations of gender correlate with other evaluations of the diagrams, such as effectiveness, visual appeal, or designer knowledge?

Having identified the traits that raters used in making gender determinations of diagram designers, I wanted to examine whether those determinations were linked to other kinds of evaluations that the raters made of the diagrams. Specifically, I wanted to determine whether raters who identified particular designs as being male-designed saw them as more or less technical, visually appealing, or effective. The idea here was to see if gender determinations could be correlated with what might be considered more "common" evaluations made of diagrams and their designers.

To accomplish this task, to determine whether lay raters' gender perceptions were related to other evaluations, I correlated items 1, 4, and 5 with item 3 from the lay rater questionnaire. Item 1 asked raters to evaluate the academic major of the designer, whether the designer was from a technical or non-technical field. This allowed raters to decide whether the designer had knowledge of the technical aspects of the design or knowledge of similar designs and processes. Items 4 and 5 asked raters to evaluate aspects of the design itself—item 4 evaluated the design's visual appeal and item 5 evaluated its effectiveness. These two items, which would seem to be the most common and most important evaluations of a process diagram, allowed the lay raters to evaluate the overall quality of the diagram. Item 3, of course, asked raters to determine the gender of the designer.

The raters' responses to items 1, 4, and 5 were tabulated individually and then correlated with the raters' determinations of gender in item 3. Item 1 responses were tabulated in the same manner as responses to item 3 had been earlier: I gave each response a T or N, for technical or non-technical, then added
a + or - depending upon the rater's certainty score (3 or above on certainty received a +, 2 or lower a -). I then calculated a technical score similar to the gender scores. A T+ rating received a -2, T- a -1, N- a 1, and N+ a 2. For items 4 and 5, I calculated the mean of the designers' responses to these items for each group. I then performed a Pearson product-moment correlation comparing the technical scores, the visual appeal means, and the effectiveness means with the gender scores for each design. This allowed me to determine whether male or female gender scores were correlated with technical or non-technical ratings, high or low visual appeal, and high or low effectiveness.

Mixing methodologies: The benefits of using quantitative and qualitative methods in this study

The study I have described in this chapter combines issues that in previous studies of gender and visuals have been kept separate. It combines research into both performance and perception, a combination called for by researchers in gender and communication as noted in Chapter 1 (e.g., Booth-Butterfield, 1993). It also combines quantitative and qualitative research methodologies, a combination that some researchers might find problematic. In this section, I discuss some of the issues involved in combining these two apparently distinct methods and I explain why the combination of the two seems appropriate.

Researchers working in English studies, as well as in education studies more generally, have suggested that quantitative and qualitative research methodologies represent competing paradigms, or world views (Stotsky, 1993; Salomon, 1991; Rizo, 1991; Larson, 1993). The debate between these two paradigms is often seen as a development of the past two decades, although Rizo
traces the roots of the debate to the seventeenth century. Kirsch (1992) argues that there are two approaches to this debate. One approach sees the two as complementary tools for analyzing the world to build a "coherent, cumulative body of knowledge" (p. 248), while the second approach argues for a methodological fidelity, arguing that researchers should "endorse a single methodology because different methodologies are likely to produce conflicting knowledge" (p. 252).

My research methods builds more upon what Kirsch (1992) terms "methodological pluralism" which sees quantitative and qualitative methods as complementary tools. In this, I build on what Larson (1993), citing Guba (1989), terms a "postpositivist" methodology. Postpositivism, among other traits, holds that "research must employ multiple probes" (p. 288). The use of both quantitative and qualitative methods in my study is an attempt to examine the issue of gender in visual communication from a variety of perspectives. Quantitatively, I analyze diagram features to determine whether there are identifiable differences in male and female performance. The traits I analyze, however, are derived from the qualitative stimulated recall interviews conducted with the raters. Unlike researchers identified by Kirsch who use qualitative methods only to develop questions for quantitative research, I embed both equally into the method of this study. In addition, I use quantitative and qualitative methods to triangulate the results. I compare, quantitatively, the appearance of design features identified by the raters in the diagrams with the gender identifications made by the raters. I qualitatively examine the reasons behind the quantitative evaluative ratings provided by the raters, as well.
In developing the method for this study, I became what Salomon (1991) calls a "pragmatist" or "eclecticist"—I combine previously competing research paradigms in ways that seem useful to answer the questions that are of interest to me. In addition, I select methods that I believe will have persuasive power for other researchers and teachers of visual and professional communication. I attempt to develop a "fluid interdependence between research paradigms" in an effort to achieve a "better, fuller, and more satisfying understanding" (Salomon, p. 16) of the nature of gender as a variable in visual communication.

Using the mixture of methods described in this chapter, I obtained results that I find very suggestive about the manner in which gender influences both the creation and interpretation of visuals in communication. These results are described in Chapter 4.
In preceding chapters, I have argued that the role of gender as a variable in the production and perception of visual elements of communication has not been studied sufficiently in professional communication. I based this argument on examinations of gender in communication and language studies, in psychological studies of visual ability, and in art and design discussions of both artistic performance and perception. In each of these areas, gender has provided a useful point of inquiry. In professional communication, however, this gendered point of inquiry has been developed in only a handful of studies.

In addition to suggesting the need for more work on gender as a variable in visual communication, I have described the method for a study examining gender in both the production of visual elements and in the perception of those elements. This study creates a starting point for a more detailed and thorough discussion of the role of gender in visual communication. Specifically, the results of this exploratory study, since it traces both actual and perceived gender differences in visual elements, allow an examination into whether real gender differences exist or whether gender differences in visual communication are the result of rater perceptions.

The study I described in the previous chapter attempts to answer five questions:

1. Can raters of a process diagram make consistent and accurate determinations of the gender of the diagram’s designer?
2. On what basis do raters make their determinations of designer gender?

3. Can the traits used for gender determinations be quantified in the diagrams and positively correlated with the self-reported gender of the designers?

4. Do the traits identified by the raters as leading to their gender identifications positively correlate with those identifications?

5. How do determinations of gender correlate with other evaluations of the diagrams, such as effectiveness, visual appeal, or designer knowledge?

The study uses a group of student-designed diagrams, lay and expert rater evaluations of those diagrams, and quantitative analyses of the diagrams to answer these four questions.

**The determination of designer gender**

The first question to be answered is whether lay raters could, in fact, identify the gender of the student-designers. In general, the results of the gender identification portion of the study indicate that raters were able to identify the gender of the diagram designers consistently and with some accuracy. There is a significant relationship between the self-reported gender of the designers and the gender identifications of the lay raters in each group. However, the relationship is stronger and the ratings more accurate among raters in Group 1, who saw the original diagrams with handwritten text, than among raters in Group 2, who used modified diagrams in which the handwriting had been replaced with typed text. Raters in Group 2 exhibited more difficulty in identifying designer gender
than did raters in Group 1. (The raw data used to derive these results are presented in Tables K.1 and K.2 in Appendix K.)

To determine whether the raters in each group were making random guesses about designer gender, I compared the gender identification responses for each group of lay raters with the self-reported gender of the student designers using a chi square analysis. Responses of raters to item 3 on the lay rater questionnaire—"This author is: ___Male ___Female"—were coded as "M+" if the rater had identified the designer's gender as male with a certainty rating of 3 or higher, "M−" if male with a certainty rating of 1 or 2, "F+" if female with 3 or higher, and "F−" if female with a 1 or 2. In the chi square analysis, a rating of M+ or M- was considered a "rated male" and a F+ or F- was considered a "rated female." For raters in both groups, the correlation of self-reported gender with rater-identified gender was statistically significant: Group 1, $x^2=97.6$ (DF1) $p<.001$; Group 2, $x^2=16.34$ (DF1) $p<.001$. (The chi-squares are presented in Tables 4.1 and 4.2.) These results indicate that there is a correlation between the self-reported gender of the designers and the gender identification of the raters in each group. In other words, the odds are fairly high that the raters' perceptions of gender were not simply random guesses about which diagrams were designed by males and which by females.

Table 4.1 Chi square comparing self-reported designer gender with Group 1 rated gender

<table>
<thead>
<tr>
<th></th>
<th>Rated male</th>
<th>Rated female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported male</td>
<td>124</td>
<td>8</td>
</tr>
<tr>
<td>Reported female</td>
<td>47</td>
<td>85</td>
</tr>
</tbody>
</table>
Table 4.2 Chi square comparing self-reported designer gender with Group 2 rated gender

<table>
<thead>
<tr>
<th></th>
<th>Rated male</th>
<th>Rated female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported male</td>
<td>104</td>
<td>28</td>
</tr>
<tr>
<td>Reported female</td>
<td>73</td>
<td>59</td>
</tr>
</tbody>
</table>

The use of the two versions of the student-authored diagrams, one with and one without handwriting, created an important secondary question: Did designer handwriting make gender identifications more accurate? The answer to this question is that, in general, handwriting did make a difference. Group 2 gender scores result in many more androgynous ratings (7 androgynous ratings) than did Group 1 gender scores (2 androgynous ratings).\(^4\) This would seem to indicate that raters in Group 2, because they did not have access to designer handwriting, had a more difficult time clearly identifying gender-specific traits within the diagrams than did raters in Group 1. Further analysis of rater accuracy indicated that the raters with access to handwriting made more accurate gender identifications than did raters who did not have access to the handwriting. To answer this question about the role of handwriting, I used the gender scores described in Chapter 3. Tables 4.3 and 4.4 show the gender score results for both groups of raters.

Further evidence of the importance of handwriting for gender identification was obtained from a chi-square analysis of the accuracy of the gender scores. For a score to be considered male, it must be less than -8 while to be considered female it must be greater than 8, since -8 and 8 serve as the ends of

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\(^4\) Androgynous scores are based on group gender scores, based on all 12 ratings for each diagram, rather than on individual raters’ scores. Individual raters did not have an “androgynous” or “undifferentiated” option on the questionnaires.
Table 4.3 Gender scores for designs rated by Group 1

<table>
<thead>
<tr>
<th>Design</th>
<th>Gender score</th>
<th>Reported gender</th>
<th>Rating totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Gender</td>
<td>M+</td>
</tr>
<tr>
<td>1</td>
<td>-24</td>
<td>M</td>
<td>11</td>
</tr>
<tr>
<td>8</td>
<td>-22</td>
<td>M</td>
<td>10</td>
</tr>
<tr>
<td>19</td>
<td>-22</td>
<td>M</td>
<td>10</td>
</tr>
<tr>
<td>22</td>
<td>-22</td>
<td>M</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>-21</td>
<td>F</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>-21</td>
<td>F</td>
<td>9</td>
</tr>
<tr>
<td>13</td>
<td>-21</td>
<td>M</td>
<td>9</td>
</tr>
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<td>18</td>
<td>-20</td>
<td>M</td>
<td>10</td>
</tr>
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<td>M</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>-18</td>
<td>M</td>
<td>9</td>
</tr>
<tr>
<td>21</td>
<td>-17</td>
<td>M</td>
<td>7</td>
</tr>
<tr>
<td>20</td>
<td>-16</td>
<td>M</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>-11</td>
<td>M</td>
<td>7</td>
</tr>
<tr>
<td>12</td>
<td>-6</td>
<td>F</td>
<td>4</td>
</tr>
<tr>
<td>16</td>
<td>3</td>
<td>F</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>8</td>
<td>F</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>F</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>F</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>19</td>
<td>F</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>22</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>23</td>
<td>F</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>23</td>
<td>F</td>
<td></td>
</tr>
</tbody>
</table>

the "androgynous zone" described in Chapter 3. Labeling each score in this way allowed me to determine whether the score was accurate or inaccurate compared to the self-reported gender of the designer. Categorizing the scores based on this analysis, and separating them into either Group 1, which saw the handwriting, or Group 2, which did not, provides the chi-square shown in Table 4.5.

The results of this chi-square analysis indicate that there is a significant relationship between seeing the handwriting in the original diagrams and making accurate gender identifications: \( x^2 = 9.50 \) (DF1) \( p < .01 \). Overall results of
Table 4.4 Gender scores for designs rated by Group 2

<table>
<thead>
<tr>
<th>Design</th>
<th>Gender score</th>
<th>Reported gender</th>
<th>Rating totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>M+</td>
</tr>
<tr>
<td>7</td>
<td>-21</td>
<td>F</td>
<td>9</td>
</tr>
<tr>
<td>19</td>
<td>-18</td>
<td>M</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>-16</td>
<td>M</td>
<td>6</td>
</tr>
<tr>
<td>15</td>
<td>-16</td>
<td>M</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>-16</td>
<td>M</td>
<td>8</td>
</tr>
<tr>
<td>22</td>
<td>-14</td>
<td>M</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>-13</td>
<td>M</td>
<td>3</td>
</tr>
<tr>
<td>13</td>
<td>-12</td>
<td>M</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>-11</td>
<td>M</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>-10</td>
<td>F</td>
<td>6</td>
</tr>
<tr>
<td>16</td>
<td>-10</td>
<td>F</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>-7</td>
<td>F</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>-7</td>
<td>F</td>
<td>3</td>
</tr>
<tr>
<td>21</td>
<td>-4</td>
<td>M</td>
<td>2</td>
</tr>
<tr>
<td>18</td>
<td>-2</td>
<td>M</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>F</td>
<td>2</td>
</tr>
<tr>
<td>20</td>
<td>2</td>
<td>M</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>F</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>F</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>F</td>
<td>2</td>
</tr>
<tr>
<td>14</td>
<td>12</td>
<td>F</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>F</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.5 Chi-square comparing access to handwriting with gender identification accuracy

<table>
<thead>
<tr>
<th>Handwriting</th>
<th>Accurate</th>
<th>Inaccurate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handwriting</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>No handwriting</td>
<td>8</td>
<td>14</td>
</tr>
</tbody>
</table>

This portion of the analysis indicate that individual raters were able to identify gender with a high degree of accuracy. As a group, however, raters in Group 1 were more accurate than were raters in Group 2, apparently because Group 1 had access to the handwriting of the designers.
Traits used in gender identification

If, as the statistical analysis of the gender identifications indicate, raters were not identifying gender randomly, then an important question arises: On what are the raters basing their gender identifications? Three specific research questions and their corresponding analyses were designed to explore this issue. First, in order to answer research question 2—on what basis do raters make their determinations of designer gender—I used responses from the post-questionnaire interviews of the lay raters in which they identified the design traits or characteristics they saw themselves using to determine designer gender. Second, to answer question 3—can the traits used for gender determinations be quantified in the diagrams and positively correlated with the self-reported gender of the designers—I performed a quantitative analysis of the designs based on the traits identified by the lay raters. Third, to answer question 4—do the traits identified by the raters as leading to their gender identifications positively correlate with those identifications—I performed a correlational analysis of the quantified trait analysis and the raters' gender scores.

Rater-identified gendered design traits

To test the existence of gender-based traits in the diagrams, I had to first determine what those traits were. I used the raters to identify those traits. During the post-questionnaire interviews, I asked raters in both groups to explain their responses to item 3 on the questionnaire, which asked them to identify the gender of the diagram designer as either male or female and to rate the certainty of their choice. To determine which traits were used most often by the raters, I catalogued all of the traits listed by each rater. I then compiled those
traits, counting the number of times each trait was mentioned and the number of raters who mentioned each trait. The results are presented in Table 4.6.

Some of the traits were mentioned in what I term “negative” ways, meaning that raters suggested the trait was not useful in evaluating a particular design. I have included these negative mentions in the compilation of traits because even though the trait was not useful in that instance, the fact that the rater mentioned it indicates that the trait was one the rater looked for in evaluating the designs and identifying gender. Handwriting provides an interesting example. Since Group 2 had no handwritten text, all of the Group 2 raters’ mentions of handwriting had to be negative; the fact that they mentioned handwriting at all, however, would seem to indicate that handwriting is used by people to identify gender outside the confines of this study.

Table 4.6 Traits raters used to identify designer gender

<table>
<thead>
<tr>
<th>Trait</th>
<th>Group 1 times mentioned/ # of raters</th>
<th>Group 2 times mentioned/ # of raters</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>artistic style/ability</td>
<td>36/11</td>
<td>30/11</td>
<td>66/22</td>
</tr>
<tr>
<td>handwriting</td>
<td>58/12</td>
<td>8/7</td>
<td>66/19</td>
</tr>
<tr>
<td>technical knowledge/content</td>
<td>11/5</td>
<td>26/8</td>
<td>37/13</td>
</tr>
<tr>
<td>neatness</td>
<td>8/4</td>
<td>27/9</td>
<td>35/13</td>
</tr>
<tr>
<td>detail</td>
<td>13/5</td>
<td>8/5</td>
<td>21/10</td>
</tr>
<tr>
<td>linearity</td>
<td>7/6</td>
<td>12/6</td>
<td>19/12</td>
</tr>
<tr>
<td>simplicity</td>
<td>2/1</td>
<td>5/4</td>
<td>7/5</td>
</tr>
<tr>
<td>pretty</td>
<td>2/2</td>
<td>2/1</td>
<td>4/3</td>
</tr>
<tr>
<td>organization</td>
<td>1/1</td>
<td>2/1</td>
<td>3/2</td>
</tr>
<tr>
<td>nice</td>
<td>1/1</td>
<td>1/1</td>
<td>2/2</td>
</tr>
<tr>
<td>textual content</td>
<td>1/1</td>
<td>1/1</td>
<td>2/2</td>
</tr>
</tbody>
</table>
These results provide a sense of how raters in the two groups justified the gender identifications they had made. Further analysis was needed to determine whether the traits raters used in justifying their gender identifications were actually present in the diagrams.

Quantification of gender identification traits

Once I had identified traits the raters believed were important for their gender ratings, I attempted to determine whether or not those traits actually appeared in the diagrams and whether the frequency of appearance depended upon the self-reported gender of the designers. Since two of the traits, artistic style and handwriting, were mentioned almost twice as often as any other and were mentioned by a large majority of the raters, I selected them as the starting point of the diagram analysis. Handwriting was a fairly straightforward item to identify and count. Artistic style, however, had a number of various components, including the use of pictures rather than words, the use of various types of pictures with varying amounts of detail, and the use of rounded or straight images. In order to determine the male and female differences in these two main traits, handwriting and artistic style, I examined the following items:

1. The use of “male” vs. “female” handwriting
2. The number of words used in the diagrams
3. The number of visual items used in the diagrams
4. The difference in types of visual items
5. The use of angles versus rounded corners
Male vs. female handwriting

I first analyzed the diagrams to determine whether the use of "male" and "female" handwriting styles, as defined by the raters, was connected to the self-reported gender of the designers. Males in this study were, by approximately a 2-to-1 margin, more likely to use "male" handwriting, and females were much more likely than males to use "female" handwriting (in fact, no male exhibited female handwriting based on the traits identified here, while almost half of the females used male handwriting). In Chapter 3, I identified the traits for male and female handwriting:

- Male handwriting was generally smaller than 14 points; upper case; "messy," containing obvious erasures, illegible words, or words that were scribbled out; angular; printed rather than written in cursive.
- Female handwriting was generally larger than 14 points; mixed case; "neat" in that it included very faint erasures, no words crossed or scribbled out, and no virtually no illegible words; rounded; and was written in cursive rather than printed.

The results of the diagram coding are shown in Table 4.7. Table 4.7 reveals one difficulty in identifying male and female traits: font size tended to vary tremendously in designs. Few designers maintained a consistent font size throughout the document. For this reason, I report the range of font sizes shown in each document. Based on the coding shown in Table 4.7, I calculated writing gender scores as described in Chapter 3. The scores and the self-reported gender of each designer are shown in Table 4.8.

Two results support the reactions of the raters to male and female handwriting styles: one, males were more likely to use "male" handwriting and
Table 4.7 Coding results of “male” and “female” handwriting features

<table>
<thead>
<tr>
<th>Design</th>
<th>Font size</th>
<th>Case</th>
<th>Mistakes</th>
<th>Angled or rounded</th>
<th>Contains cursive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13</td>
<td>mixed</td>
<td>3</td>
<td>angled</td>
<td>no</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>caps</td>
<td>0</td>
<td>angled</td>
<td>no</td>
</tr>
<tr>
<td>3</td>
<td>14-18</td>
<td>mixed</td>
<td>0</td>
<td>curved</td>
<td>no</td>
</tr>
<tr>
<td>4</td>
<td>12-14</td>
<td>caps</td>
<td>0</td>
<td>curved</td>
<td>no</td>
</tr>
<tr>
<td>5</td>
<td>10-12</td>
<td>caps</td>
<td>0</td>
<td>angled</td>
<td>no</td>
</tr>
<tr>
<td>6</td>
<td>8-14</td>
<td>caps</td>
<td>1</td>
<td>angled</td>
<td>no</td>
</tr>
<tr>
<td>7</td>
<td>14-18</td>
<td>lower</td>
<td>0</td>
<td>curved</td>
<td>yes</td>
</tr>
<tr>
<td>8</td>
<td>10-14</td>
<td>lower</td>
<td>2</td>
<td>angled</td>
<td>no</td>
</tr>
<tr>
<td>9</td>
<td>24-28</td>
<td>mixed</td>
<td>0</td>
<td>curved</td>
<td>no</td>
</tr>
<tr>
<td>10</td>
<td>8-13</td>
<td>caps</td>
<td>2</td>
<td>angled</td>
<td>no</td>
</tr>
<tr>
<td>11</td>
<td>8-14</td>
<td>mixed</td>
<td>0</td>
<td>curved</td>
<td>no</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>caps</td>
<td>0</td>
<td>angled</td>
<td>no</td>
</tr>
<tr>
<td>13</td>
<td>10-20</td>
<td>mixed</td>
<td>6</td>
<td>angled</td>
<td>no</td>
</tr>
<tr>
<td>14</td>
<td>6-10</td>
<td>caps</td>
<td>3</td>
<td>mixed</td>
<td>no</td>
</tr>
<tr>
<td>15</td>
<td>8-12</td>
<td>mixed</td>
<td>3</td>
<td>curved</td>
<td>no</td>
</tr>
<tr>
<td>16</td>
<td>14-24</td>
<td>mixed</td>
<td>6</td>
<td>mixed</td>
<td>no</td>
</tr>
<tr>
<td>17</td>
<td>8-24</td>
<td>lower</td>
<td>4</td>
<td>curved</td>
<td>yes</td>
</tr>
<tr>
<td>18</td>
<td>9-14</td>
<td>caps</td>
<td>3</td>
<td>angled</td>
<td>no</td>
</tr>
<tr>
<td>19</td>
<td>10-24</td>
<td>lower</td>
<td>7</td>
<td>angled</td>
<td>no</td>
</tr>
<tr>
<td>20</td>
<td>10-14</td>
<td>mixed</td>
<td>6</td>
<td>angled</td>
<td>yes</td>
</tr>
<tr>
<td>21</td>
<td>10-20</td>
<td>mixed</td>
<td>3</td>
<td>angled</td>
<td>no</td>
</tr>
<tr>
<td>22</td>
<td>8-10</td>
<td>caps</td>
<td>2</td>
<td>angled</td>
<td>no</td>
</tr>
</tbody>
</table>

did not use “female” handwriting at all; two, the apparently large difference between the mean scores. However, a statistical comparison of writing gender scores and self-reported gender indicates that there is no significant statistical difference between male and female use of “male” and “female” handwriting, \( t = -1.6 \) (DF 20) n.s. The difference between the apparent validity of the raters’ reactions and the lack of statistical significance may be due to the small sample size; using a larger number of diagrams might lead to statistical significance. Regardless of the lack of statistical significance, however, there is sufficient
Table 4.8 Comparison of writing gender to rated and self-reported gender

<table>
<thead>
<tr>
<th>Design</th>
<th>Writing gender</th>
<th>Actual gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>-5</td>
<td>male</td>
</tr>
<tr>
<td>14</td>
<td>-4</td>
<td>female</td>
</tr>
<tr>
<td>1</td>
<td>-3</td>
<td>male</td>
</tr>
<tr>
<td>2</td>
<td>-3</td>
<td>male</td>
</tr>
<tr>
<td>5</td>
<td>-3</td>
<td>female</td>
</tr>
<tr>
<td>6</td>
<td>-3</td>
<td>female</td>
</tr>
<tr>
<td>10</td>
<td>-3</td>
<td>female</td>
</tr>
<tr>
<td>12</td>
<td>-3</td>
<td>female</td>
</tr>
<tr>
<td>22</td>
<td>-3</td>
<td>male</td>
</tr>
<tr>
<td>8</td>
<td>-2</td>
<td>male</td>
</tr>
<tr>
<td>19</td>
<td>-2</td>
<td>male</td>
</tr>
<tr>
<td>4</td>
<td>-1</td>
<td>male</td>
</tr>
<tr>
<td>13</td>
<td>-1</td>
<td>male</td>
</tr>
<tr>
<td>15</td>
<td>-1</td>
<td>male</td>
</tr>
<tr>
<td>20</td>
<td>-1</td>
<td>male</td>
</tr>
<tr>
<td>21</td>
<td>-1</td>
<td>male</td>
</tr>
<tr>
<td>16</td>
<td>0</td>
<td>female</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>female</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>female</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>female</td>
</tr>
<tr>
<td>9</td>
<td>3</td>
<td>female</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>female</td>
</tr>
</tbody>
</table>

male mean: -1.909
female mean: -.273

evidence to indicate that the raters in Group 1 might, in fact, have been reacting to a verifiable aspect of the design in making their gender identifications.

Number of words

The next issue for examination was whether male or female designers used more words in the diagrams. The results here, too, are more suggestive than statistically significant, indicating that male designers in this study were
likely to use more words than were female designers. Based on the criteria for word counts described in Chapter 3, I tabulated the number of words used by males and females in the diagrams. The results are shown in Table 4.9. The mean number of words in male-designed diagrams was 68.36, while in female-designed diagrams the mean was 50.27. However, even though there is a large difference between the mean number of words, independent t-test analysis indicates that this difference is not statistically significant, \( t=1.16 \) (DF 20) \( p=.260 \). As was the case with writing gender scores, this result may be due to the limited number of samples, in which case using more diagrams might reveal a statistically significant difference between number of words used in male- and female-designed diagrams. While the difference is not statistically significant, it is large enough to be suggestive in terms of what raters identified in the diagrams—there does seem to be an identifiable difference in the number of words used by male and female designers of the diagrams used in this study.

<table>
<thead>
<tr>
<th>Male designers</th>
<th>Female designers</th>
</tr>
</thead>
<tbody>
<tr>
<td>77</td>
<td>40</td>
</tr>
<tr>
<td>50</td>
<td>102</td>
</tr>
<tr>
<td>77</td>
<td>26</td>
</tr>
<tr>
<td>65</td>
<td>92</td>
</tr>
<tr>
<td>174</td>
<td>12</td>
</tr>
<tr>
<td>37</td>
<td>63</td>
</tr>
<tr>
<td>51</td>
<td>94</td>
</tr>
<tr>
<td>67</td>
<td>1</td>
</tr>
<tr>
<td>79</td>
<td>34</td>
</tr>
<tr>
<td>44</td>
<td>31</td>
</tr>
<tr>
<td>31</td>
<td>58</td>
</tr>
</tbody>
</table>

mean: 68.36 mean: 50.27
Number of visual items

After counting the number of words, I also determined whether male designers used fewer visual items in their diagrams. Female use of visual items tends to be slightly higher than male use although the differences are not statistically significant. The results of this tabulation are shown in Table 4.10. The means for total number of visual items in male- and female-designed diagrams were closer than were means for number of words: male 32.00 and female 39.36. And, like the number of words and gender writing scores, differences between the number of visual items used by males and females were not statistically significant according to an independent t-test (t=1.159, DF=20, p=.260). There is some apparent difference, in that female designer numbers go slightly higher than males and do not go quite as low; in other words, overall female use of visual items does tend to run slightly higher than males, as the means indicate. For these visual counts, there was an overall interrater reliability of .989 using a Pearson correlation.5

Because individually both the word count and the visual items count were suggestive of gender-based differences, I decided to further test the idea that female designers were more "picture-oriented." I completed an additional analysis comparing number of words to number of visual items. I divided each designer’s total number of words by her or his total number of visual items, 5

---

5 The overall reliability represents the interrater reliability for the total image count. Reliability on individual image types was as follows: replica, .516; stylized, .772; indexical, .987; and symbolic, .979. With the exception of replica images, all of these correlations fall well within acceptable levels for composition research which is generally a .70. The reliability for replica images falls somewhat short of that but still represents a strong, statistically significant correlation. The replica correlation is low as a result of one difference in counting of images on diagram 9, where six thermometers were counted as replica images by one rater and as stylized by the other.
Table 4.10 Number of visual items used in male- and female-designed diagrams

<table>
<thead>
<tr>
<th>Male designers</th>
<th>Female designers</th>
</tr>
</thead>
<tbody>
<tr>
<td>59</td>
<td>77</td>
</tr>
<tr>
<td>46</td>
<td>57</td>
</tr>
<tr>
<td>45</td>
<td>52</td>
</tr>
<tr>
<td>38</td>
<td>50</td>
</tr>
<tr>
<td>37</td>
<td>47</td>
</tr>
<tr>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td>28</td>
<td>29</td>
</tr>
<tr>
<td>23</td>
<td>29</td>
</tr>
<tr>
<td>19</td>
<td>28</td>
</tr>
<tr>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>9</td>
<td>15</td>
</tr>
</tbody>
</table>

mean: 32.00       mean: 39.36

which provided a word:visual item ratio. The results of this analysis confirm the suggestive findings of the previous analysis, indicating that males in this study use more than twice as many words per picture as do females. Table 4.11 presents the resulting ratios. An independent t-test of the male and female ratios of words to visual items indicated that the differences are approaching statistical significance: $t=2.031$ (DF=20) $p=.056$. While they are still not quite statistically significant, the results of the ratio analysis do seem to support the claims of the raters that there were gender-based differences between the “picture-oriented” versus “text-oriented” nature of the diagrams.

**Types of visual items**

Another aspect of quantifying male and female differences in the use of visual items was to determine whether male and female designers used different types of visual items. After counting the total number of visual items in each diagram, I classified each item according to the Killingsworth and Gilbertson
Table 4.11 Ratio of words to visual items used in male- and female-designed diagrams

<table>
<thead>
<tr>
<th>Male designers</th>
<th>Female designers</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.56</td>
<td>3.19</td>
</tr>
<tr>
<td>4.53</td>
<td>2</td>
</tr>
<tr>
<td>3.78</td>
<td>2</td>
</tr>
<tr>
<td>3.42</td>
<td>1.61</td>
</tr>
<tr>
<td>2.91</td>
<td>1.22</td>
</tr>
<tr>
<td>1.76</td>
<td>1.21</td>
</tr>
<tr>
<td>1.61</td>
<td>1.07</td>
</tr>
<tr>
<td>1.19</td>
<td>.55</td>
</tr>
<tr>
<td>1.11</td>
<td>.43</td>
</tr>
<tr>
<td>.97</td>
<td>.8</td>
</tr>
<tr>
<td>.86</td>
<td>.07</td>
</tr>
<tr>
<td>mean: 2.791</td>
<td>mean: 1.286</td>
</tr>
</tbody>
</table>

(1993) categories described in Chapter 3: iconic/replica, iconic/stylized, index, and symbol. The results of this stage of the analysis are presented in Tables 4.12 and 4.13. The differences between male and female use of these four items were analyzed using independent t-tests, with the results shown in Table 4.14. None of the results for these four types of visuals compared with the self-reported gender of the designers is statistically significant although the use of stylized items is approaching significance. Statistically, then, there are no significant differences in the use of any of the four types of visual items between male and female designers in this study.

Angled versus rounded corners

The final question for analysis in this section was whether male and female designers used different numbers of angled and rounded corners in visual elements. This analysis attempted to verify raters' comments that female
Table 4.12 Male use of four types of visual items

<table>
<thead>
<tr>
<th>Design</th>
<th>Replica</th>
<th>Stylized</th>
<th>Index</th>
<th>Symbol</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>22</td>
<td>1</td>
<td>6</td>
<td>31</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>13</td>
<td>0</td>
<td>26</td>
<td>12</td>
<td>8</td>
<td>46</td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>10</td>
<td>10</td>
<td>14</td>
<td>38</td>
</tr>
<tr>
<td>18</td>
<td>0</td>
<td>41</td>
<td>7</td>
<td>11</td>
<td>59</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>17</td>
<td>3</td>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
<td>18</td>
<td>20</td>
<td>7</td>
<td>45</td>
</tr>
<tr>
<td>21</td>
<td>1</td>
<td>20</td>
<td>0</td>
<td>16</td>
<td>37</td>
</tr>
<tr>
<td>22</td>
<td>0</td>
<td>0</td>
<td>27</td>
<td>1</td>
<td>28</td>
</tr>
<tr>
<td>means</td>
<td>.82</td>
<td>14.72</td>
<td>9.73</td>
<td>6.73</td>
<td>32.00</td>
</tr>
</tbody>
</table>

Table 4.13 Female use of four types of visual items

<table>
<thead>
<tr>
<th>Design</th>
<th>Replica</th>
<th>Stylized</th>
<th>Index</th>
<th>Symbol</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
<td>25</td>
<td>12</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>15</td>
<td>8</td>
<td>1</td>
<td>32</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>21</td>
<td>9</td>
<td>17</td>
<td>47</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>29</td>
<td>10</td>
<td>18</td>
<td>57</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>24</td>
<td>0</td>
<td>4</td>
<td>28</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>29</td>
<td>11</td>
<td>12</td>
<td>52</td>
</tr>
<tr>
<td>11</td>
<td>0</td>
<td>48</td>
<td>3</td>
<td>26</td>
<td>77</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>14</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>14</td>
<td>8</td>
<td>6</td>
<td>29</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>22</td>
<td>5</td>
<td>1</td>
<td>29</td>
</tr>
<tr>
<td>means</td>
<td>1.18</td>
<td>23.18</td>
<td>6.00</td>
<td>9.00</td>
<td>39.36</td>
</tr>
</tbody>
</table>

Table 4.14 Results of t-test on four types of visuals and self-reported gender of designers

<table>
<thead>
<tr>
<th></th>
<th>T</th>
<th>DF</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>replica</td>
<td>-.440</td>
<td>20</td>
<td>.665</td>
</tr>
<tr>
<td>stylized</td>
<td>-1.724</td>
<td>20</td>
<td>.100</td>
</tr>
<tr>
<td>index</td>
<td>1.290</td>
<td>20</td>
<td>.212</td>
</tr>
<tr>
<td>symbol</td>
<td>-.763</td>
<td>20</td>
<td>.454</td>
</tr>
</tbody>
</table>
drawings were more curved than were male drawings, a perception supported by Bosley's (1993) findings, as well. As described in Chapter 3, it seemed necessary to separate attempts at replication of real objects, in which angled or round corners might be determined by the objects themselves, from other visual items, in which choosing rounded or angled corners would seem to be entirely a matter of designer preference. Because of this, I counted rounded and angled corners only in stylized, indexical, and symbolic visual elements. The results of my analysis of the use of rounded and angled corners indicate that male designers in this study do use more angled corners than female designers. The number of rounded and angled corners used by male and female designers is shown in Tables 4.15 and 4.16.

Because of the wide variation in number of cornered items in the diagrams, I decided to analyze rounded and angled corners using ratios similar to those I used with words and visual elements above. However, because some of the diagrams had no rounded corners, I could not divide angled corners by rounded corners. Instead, I divided the number of angled corners by the total

<table>
<thead>
<tr>
<th>Male designers</th>
<th>Female designers</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>26</td>
</tr>
<tr>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>47</td>
<td>34</td>
</tr>
<tr>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>24</td>
<td>32</td>
</tr>
<tr>
<td>45</td>
<td>34</td>
</tr>
<tr>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>70</td>
<td>43</td>
</tr>
<tr>
<td>21</td>
<td>14</td>
</tr>
<tr>
<td>35</td>
<td>30</td>
</tr>
</tbody>
</table>

mean: 30.09
mean: 27.73
number of corners for each diagram. This gave an angled percentage, as shown in Table 4.17.

A t-test performed on these percentages indicated that the differences between male and female use of angled corners is approaching statistical significance, $t=1.894$ (DF=20) $p=.073$. For interrater reliability, Pearson product-moment correlations indicated a strong correlation between my counts and those of the other rater: rounded corners, $R=.813$; angled corners, $R=.982$; and total corners, $R=.996$. This seems to lend some support to the raters who suggested that male and female designers use curves and angles in different proportions.

**Rater identified traits and gender scores**

The next issue I examined was whether the traits identified by the raters as leading to their gender identifications seemed to be accurate; in other words, did the existence of those traits correlate with the gender determinations the raters

---

6 Prior to conducting the t-test, I transformed these percentages with a logarithmic function to make them appropriate for parametric statistical computation.
Table 4.17 Percentage of angled corners in male- and female-designed diagrams

<table>
<thead>
<tr>
<th>Male designers</th>
<th>Female designers</th>
</tr>
</thead>
<tbody>
<tr>
<td>68</td>
<td>68</td>
</tr>
<tr>
<td>83</td>
<td>97</td>
</tr>
<tr>
<td>100</td>
<td>77</td>
</tr>
<tr>
<td>96</td>
<td>74</td>
</tr>
<tr>
<td>97</td>
<td>74</td>
</tr>
<tr>
<td>100</td>
<td>76</td>
</tr>
<tr>
<td>57</td>
<td>72</td>
</tr>
<tr>
<td>78</td>
<td>63</td>
</tr>
<tr>
<td>86</td>
<td>84</td>
</tr>
<tr>
<td>78</td>
<td>64</td>
</tr>
<tr>
<td>92</td>
<td>70</td>
</tr>
</tbody>
</table>

mean: 85.00  mean: 74.45

made? Of the traits examined, only two, writing gender scores and the use of replica images, show any statistically significant relationship to the gender scores of raters in either group. To derive this answer, I completed a correlation analysis for group gender scores and the traits examined in the above quantified analysis. The results are shown in Table 4.18.

Table 4.18 Correlation table of Group 1 and Group 2 gender scores, writing gender score, word count, image-to-word ratio, and angled corner percentage

<table>
<thead>
<tr>
<th></th>
<th>Group 1 gender score</th>
<th>Group 2 gender score</th>
</tr>
</thead>
<tbody>
<tr>
<td>writing gender</td>
<td>.524*</td>
<td>n/a</td>
</tr>
<tr>
<td>image/word ratio</td>
<td>-.294</td>
<td>-.250</td>
</tr>
<tr>
<td>replica</td>
<td>.224</td>
<td>.408*</td>
</tr>
<tr>
<td>stylized</td>
<td>.152</td>
<td>.105</td>
</tr>
<tr>
<td>index</td>
<td>-.217</td>
<td>-.146</td>
</tr>
<tr>
<td>symbol</td>
<td>-.053</td>
<td>-.162</td>
</tr>
<tr>
<td>angled corner %</td>
<td>-.268</td>
<td>-.100</td>
</tr>
</tbody>
</table>
Gender identification and other evaluations

The final research question for this study was whether raters' gender identifications correlated with the other evaluations raters were asked to make. Raters were asked to evaluate the technical background of the designer (questionnaire item 1), the visual appeal of the design (item 4), and the overall effectiveness of the design (item 5). A correlational analysis did indicate that there were some significant correlations between the gender scores and the mean technical and visual appeal ratings for each diagram. A multiple regression analysis, which I completed to explore how much technical ratings, visual appeal, and effectiveness might have contributed to the raters' identification of gender, also supported the significant influence of the technical ratings and visual appeal. In both analyses, however, effectiveness seemed to have no significant relationship to raters' gender identifications.

Correlation between gender score and other evaluations

The first issue involved in this portion of the analysis was whether there was any positive or negative correlation between the gender scores and the raters' evaluations of the designers' technical backgrounds or the visual appeal or effectiveness of the diagrams. While the results are mixed, there are some significant correlations that occur in the ratings. The results of the correlation analyses are presented in Table 4.19.

As Table 4.19 indicates, significant positive correlations can be found in Group 1 for gender score and technical rating and in Group 2 for gender score and visual appeal. The positive correlation indicates that as the gender score
Table 4.19 Correlation table of Group 1 and Group 2 ratings of gender, technical major, visual appeal, and effectiveness

<table>
<thead>
<tr>
<th></th>
<th>Group 1 gender score</th>
<th>Group 2 gender score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical rating</td>
<td>.542*</td>
<td>.101</td>
</tr>
<tr>
<td>Visual appeal</td>
<td>.305</td>
<td>.715*</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>-.198</td>
<td>.288</td>
</tr>
</tbody>
</table>

In this case, as the score progresses toward the female end of the continuum, Group 1 was more likely to see the designer as having a non-technical background and Group 2 was more likely to view the diagrams as visually appealing. In both groups the correlations of effectiveness and gender scores are not statistically significant, not allowing any conclusions to be drawn about the relationship between gender scores and effectiveness from this study. Overall, both groups’ gender scores are most strongly correlated with visual appeal, indicating that raters in both groups tended to view what they perceived as female-designed diagrams as more visually appealing.

Determining the impact of visual appeal, technical rating, and effectiveness on gender identification

In order to further explore the relationships between gender scores, visual appeal, technical rating, and effectiveness, I completed multiple regressions for both Group 1 and Group 2. These regressions allowed me to examine how much influence each evaluation—visual appeal, technical rating, and effectiveness—might have had on the gender identifications of the raters as reflected in the gender scores. Multiple regressions allow each variable to be considered relative to the other variables, allowing for a better comparison of each variable’s influence on the gender identifications made by the raters. What I found in
these regressions was that, as the correlations suggest, the technical ratings and visual appeal ratings were significant indicators of the gender scores for both groups, while the effectiveness ratings were not (Group 1: R=.674, F=4.996, DF=3,18, p<.01; Group 2: R=.796, F=10.389, DF=3,18, p<.001).

The results presented in this chapter are descriptive rather than definitive. In some analyses, the number of diagrams is too small to allow statistical generalization. In all analyses, the issues are too new, the study too contextually specific, and the results generally too mixed to allow generalization. The results are suggestive, though, even more so because they seem to match research results in other disciplines and contexts. The potential implications of these results for understanding how gender might affect visual communication and for further research in this area are discussed in the next chapter.
Logue and Miller (1995), in their discussion of rhetorical status, suggest that gender is one of a number of socially constructed identities people use in communicative interactions to position themselves relative to other participants. The results presented in Chapter 4 provide some insight into how gender was used by the 24 graduate raters in this study to position the undergraduate designers of the sunflowerseed oil extraction diagrams. The results also suggest some ways in which gender might have affected the designers themselves. In this chapter, I discuss the results presented in Chapter 4, examining how those results tie into issues involved in professional communication as well as gender research in communication more generally.

To flesh out the statistical and quantitative analyses presented in Chapter 4, I introduce the comments of the raters, many of whom provided important insights about how gender operates in professional communication within their disciplines. In addition, I explore the implications of the results of my study for future studies of gender and visual communication.

I sought to explore five questions with this study:

1. Can raters of a process diagram make consistent and accurate determinations of the gender of the diagram’s designer?

2. On what basis do raters make their determinations of designer gender?
3. Can the traits used for gender determinations be quantified in the diagrams and positively correlated with the self-reported gender of the designers?

4. Do the traits identified by the raters as leading to their gender identifications positively correlate with those identifications?

5. How do determinations of gender correlate with other evaluations of the diagrams, such as effectiveness, visual appeal, or designer knowledge?

I also set out to explore the relationship between perceived and actual performance differences in male and female designers. To highlight the differences and similarities between performance and perception, I have re-ordered the research questions with which I began this study. I will first discuss the performance question—Can the traits used for gender determinations be quantified in the diagrams and correlated with reported gender?—and then go on to discuss the other four questions which all deal with perceived gender differences. Throughout the chapter, I use Logue and Miller's (1995) rhetorical status as a framework for understanding and explaining the results of this study.

**Performance differences: Cues for identifying social status**

Logue and Miller (1995) suggest that characteristics used in forming rhetorical status "manifest themselves in different ways" in various communicative interactions (p. 22). The study of gender-based performance differences is, essentially, a study of the communicative manifestations of socially constructed gender identities. In this study, I examine whether traits that
raters believed were manifest in the diagrams actually were. In an effort to
determine whether traits identified by the raters as contributors to their gender
identifications could be quantified and compared in the actual diagrams, I
examined five traits:

1. use of "male" vs. "female" handwriting
2. number of words used in the diagrams
3. number of visual items used in the diagrams
4. difference in types of visual items
5. use of angles versus rounded corners

Of these five traits, the types of visuals showed only slight identifiable differences
between males and females. Three traits—handwriting, number of words, and
number of visual items—showed identifiable but not statistically significant
differences. Two traits—image-to-words ratio and angled corners—showed
identifiable differences that were approaching significance. In this section, I
discuss these findings, beginning with those traits that showed no difference,
then moving to the traits that showed some difference. I show how these results
are related to other research, and I discuss potential implications of these results
for professional communication. Finally, I discuss the limitations of this study.

Types of visuals

Numerically, there were only fairly small differences between male and
female use of four types of visuals—replica, stylized, indexical, and symbolic—in
the diagrams in this study. The differences in how individuals used these visual
types indicate that the categories seem useful for analyzing diagrams and perhaps
other kinds of visual communication, as well. Some individuals used only
indexical visuals, creating flow charts of the process in which the only visuals
present were the frames and connecting arrows or lines designed to lead the reader from one concept to the next. Others created diagrams that emphasized stylized iconic representations, creating relatively abstract icons for each step of the process. Nearly every designer used some symbolic elements, very conventionalized ways of representing particular meanings, while only a few designers attempted to create visuals that were fairly detailed representations of actual parts of the oil extraction process.

These differences seem attributable, in this study, to something other than self-reported gender. One potential source of the differences might be technical knowledge or background—raters often suggested that heavy use of stylized and indexical images might be due to a lack of specific technical knowledge of the process. The fact that the study used a technical process with which the designers were not familiar might have led designers to use more abstract images. Trained designers would be expected to research the process they were representing, which would seem to decrease this particular problem. Other differences might also be caused by training or different artistic abilities among the designers. Some of the designers might have felt uncomfortable with their ability to draw more representational images and so relied on more abstract images to convey the information. This might also be the reason a few designers chose to use flow chart formats that used only very common indexical images.

Boardman (1990) explains that experience and knowledge can alter mapping practices among children. Because experiential differences are often connected to gender, this can lead to gender differences in mapping as well as other design behaviors. In this study, however, the lack of experience with the sunflowerseed oil extraction process was not gender specific and so might have
contributed to the lack of strong gender-based differences in use of the four visual types. While the categories of replica, stylized, indexical, and symbolic images seem useful for analysis, further studies might provide a better examination of potential gender differences by examining the work of designers who are experts in the subject matter of the design itself.

**Handwriting**

Differences in male and female handwriting styles were not statistically significant, but they were suggestive. While females were found to use both male and female handwriting styles, males used only the male style. This seems to be the reason no statistical differences were found—enough females (almost half) "crossed over" into the male style to eliminate statistical difference. However, the fact that males in this study do not use the rounded letters and larger point sizes of the female style is an interesting finding. Unger and Crawford (1992) note that "in reality, men and women, and boys and girls often show characteristics ascribed to the other sex [gender]" (p. 18); however, among the designers in this study, the movement seems to be only one way, with women exhibiting both sets of characteristics, and men exhibiting only one set.

The fact that women in this study seem to use "male" handwriting styles while men do not use "female" styles certainly leads to questions about how boys and girls are taught to write and what influences the development of personal writing styles. It could be that since many of the female student designers were in science or engineering fields, where the male style of writing is preferred, they had developed this style of writing as part of their academic training. The same could be said of male students, some of whom might have developed personal handwriting styles far different from what they displayed in their diagrams for
this study. Certain disciplines do privilege particular handwriting styles. While completing this study, I found a textbook written to teach graphic design to engineers. The first chapter of the textbook consisted of very thorough instructions on how to write in the proper engineering style: using a *sans serif*, all capital letters, printed hand. This type of training could certainly influence both male and female handwriting styles, promoting a greater uniformity than might occur otherwise.

This uni-directional movement in handwriting parallels a finding in research into male and female vocabularies. Arliss (1991) explains that “change may be occurring in terms of condoning the use of traditionally male-appropriate language by females, but not in terms of condoning the use of traditionally female-appropriate language by males” (p. 53). The importance of differences in handwriting styles is discussed in some detail in the perception section on handwriting. At this point it seems sufficient to note that there seems to be enough difference in handwriting among male and female designers in this study to justify its use by raters as a gender identifier.

The criteria I developed from the raters’ comments to analyze male and female handwriting styles did seem inadequate in some respects. Cursive writing, for example, which was named by some raters as a female characteristic was used very little by designers in this study. Perhaps a more specific description, indicating connectors between some letters or the presence of serif-type extensions on letters would have allowed more subtle distinctions between the print styles of males and females. In addition, the use of unlined paper for creating the designs might have contributed to the large variations in point sizes within individual designs. Similarly, handwriting might have been affected by
designers attempting to fit too much material on a single sheet of paper, even though the instructions they were given allowed them to use more than one sheet (only one designer chose to do so).

Further research into handwriting styles might examine more spontaneous handwriting situations in workplace contexts, such as note writing on the job or handwriting on story boards, chalkboards, or easels. I saw one example of the kind of situation in which handwriting spontaneously arises in the O.J. Simpson trial. A DNA expert, while testifying, used a large easel to explain for the jury how DNA worked. The expert, a woman, wrote in a flowing, cursive style using a mixture of upper- and lower-case letters—a good example of "female" handwriting. Situations such as this one might provide insight into how men and women use handwriting in workplace contexts. Research might also take into account training participants receive in handwriting. For example, people who as children attended certain types of schools or schools in certain geographical areas might have been exposed to varying amounts of handwriting training. This training could potentially alter their adult handwriting. Despite the limitations of this study, the issue of handwriting differences provides an interesting, identifiable difference between male and female designers.

Number of words and visuals

I have chosen to combine words and visuals in this discussion because it is the combination, in the sense of the ratio of total words to total images, that is approaching significance in the differences of male and female designers. Taken individually, the number of words and the number of images do provide identifiable but not significant differences. In this study, male designers tended to use more words than did female designers, and females used more images
than did males. The use of more words by male designers would seem to contradict somewhat traditional findings about male and female differences which generally find women to be more verbally skilled than men (Wolf & Gow, 1985; White, 1986; Kimura, 1992). The use of a greater number of images by women seems in keeping with stereotypical ideas that women are more skilled at drawing than men (Collins, 1994). When the ratio of words to images is considered, the difference between men and women becomes more striking and more clear: women in this study used about the same number of words as images, while men used almost three words per image.

There are a number of ways in which these results can be interpreted. A descriptive interpretation would simply conclude that for some reason women in this study found it necessary or useful to include more visual items and fewer words, and men found it necessary or useful to provide fewer visuals and more words. A more evaluative interpretation might conclude that women provided a more integrated combination of visuals and words, which is a commendable trait in designing visual explanations of processes. At the same time, men provided more explanatory material about the process, which would seem to make male-designed diagrams potentially more effective. This study does not allow these kind of evaluative conclusions, however, since it does not analyze textual material by function, which might allow determining when text functioned in an integrated or explanatory matter. This would certainly be one area for further research, to determine whether there are identifiable differences between male and female designers in the amount of integration between verbal and visual elements and whether male designers provide more explanatory textual matter.
Another potentially critical area for further research would be to examine the role professional training plays in image selection. Individuals trained as technical illustrators might display more similarity than difference across genders in their use of visuals and words. Workplace conventions might operate similarly, leveling out potential gender differences by forcing people to adopt conventional choices of words and images. While student designers in this study all came from technical backgrounds (with the one exception of the technical writing major), because they are undergraduates they are not necessarily trained in the design conventions of their disciplines. Training they have received is more likely to deal with reading than with creating technical designs. Future research might compare the results of this study with similar studies of workplace communicators creating conventional visual documents.

This comparison of male and female behaviors also confirms a critique of gender research. There seems to be as much intra-gender variation as there is inter-gender variation (Smythe & Schlueter, 1989; Wolf & Gow, 1985). For word counts in the diagrams, males designers in this study range from 31 to 174 words, and females range from 1 to 102. Visual components of the diagrams are similarly varied, with males ranging from 9 to 59 and females from 15 to 77. Further research might attempt to divide groups along a variety of characteristics in addition to gender—academic major, number of art courses, experiences in English—that could contribute to these types of differences. Comparisons could then be made among gender and a variety of other variables. In addition, there is some evidence that gendered self-concept, a more complicated determination of how a person feels about his or her gender identity, might affect individual use of words and visuals (Newcombe & Dubas, 1992; Ozer, 1987; Signorella &
Studies that use gendered self-concept of the designers might explain the kind of intra-gender variation found in this study.

**Angled versus rounded corners**

One aspect of female design behavior that has received some attention in the past is a reported female tendency to use more rounded, circular shapes than males (Munroe, Munroe, & Lansky, 1976). This study supports that conclusion. The male designers in this study tended to use more angled corners in their designs than did females. Bosley (1992) found similar results in her study of first-year college students designing a water purification process diagram.

Concerning the use of rounded and angular visual elements, Bosley asks, “Do females have a disadvantage in visual communication because of their tendency to produce rounded shapes” (p. 228)? To the extent that linearity of form is perceived as a rational trait—as Bosley argues based on her research in feminist theory—and circularity as a non-rational trait, designers who emphasize circular elements might be seen as being disadvantaged. If female designers tend to create more rounded diagrams than male designers, then the answer to Bosley’s question might be “yes.” (This is discussed in more detail under “Technical background” below.) Both male and female designers might be disadvantaged, however, if drawing style is dependent upon gender-based preferences. Rounded and angled corners would both seem to be useful drawing techniques under various circumstances. Relying on one or the other universally would seem to be detrimental to good design practice.

There are two important limitations to this portion of the study. One, because undergraduate designers were used rather than design or visual communication specialists, it is impossible to know what effect design training
might have on the use of rounded and angled corners. Certainly there are conventions that trained designers might use in diagrams such as those used in this study. Those conventions might outweigh personal preferences thereby minimizing gender differences. That the designs used in this study were essentially rough sketches of designs might have actually contributed to this problem. Even these designers who have had no real design training might have modified the roundedness or angularity of some objects if completing them more formally. Two, the analysis of corners in this study left unanalyzed a number of other design features. I purposefully omitted replica images because they seemed to curtail designer preference. However, there might be some aspect of drawing replicas that is related to the angular or rounded nature of the designs. In addition, since I counted only corners, there might be other lines and elements that could mediate the angle/corner differences between male and female designers.

Implications for professional communication

Because the results of this study are suggestive rather than statistically significant and the number of diagrams analyzed is relatively small, the implications of the results of performance differences between male and female designers are all potential rather than actual. If, in fact, the results of this study could be generalized to people working in professional communication contexts—to engineers creating reports, technical communicators creating software documentation, or to sunflowerseed oil researchers creating a process diagram—the implications could be very important. If males and females have different design preferences, then there is a potential for conflicts between members of mixed-gender working groups, or between subordinates and
supervisors over what a particular design ought to look like. In addition, rewards might be distributed differently on the basis of what is perceived as appropriate design strategies that might be gender-influenced. What is seen as effective design practices in various contexts and documents might be correlated with male or female design preferences.

From the standpoint of rhetorical status, these differences can be seen as “cues” to identifying social status, thus allowing typing and ranking to occur. Because these cues themselves are connected to social identity, in this case gender, they can be seen as socially derived—they occur in part because the designers’ own rhetorical status is based on social identities that privilege certain behaviors. Seeing performance differences in terms of rhetorical status and understanding the potential implications of these differences places actual performance differences in the realm of perceived differences: unless there is a perception of difference, it would seem that actual differences wouldn’t matter. In the following sections, I discuss the perception of differences among the raters as well as the potential implications of these perceptions.

Assigning rhetorical status: Perceptions of gender-based differences in the diagrams

Rhetorical status, as described above, suggests that four things happen in a communicative interaction: (1) communicators identify characteristics of one another based on manifested behaviors; (2) communicators rank and/or type one another using social identities; (3) communicators evaluate, based on their ranking and typing, one another’s relative competence, abilities, etc., in other words, assign rhetorical status; and (4) communicators use rhetorical status to
filter and interpret meanings, thereby affecting communication outcomes. In discussing the results of the perception-based portions of my study, I show how these four things occur in the evaluations of the raters. Raters identify gender based on a particular set of behaviors they believe occur in the diagrams. Raters identify a number of traits based on the designers' gendered social identity. The gender identities contribute to evaluations of other aspects of the diagrams, which affects how raters perceive the overall usefulness of the diagrams for communication. In this section, I discuss each of these aspects of rhetorical status as they occur in the results for each of the remaining four research questions.

**Can raters of a process diagram make consistent and accurate determinations of the gender of the diagram's designer?**

After I had completed the official interview of rater 9, a female Master's degree student in biomedical engineering, I explained to her the nature of my research, that I was examining how gender affected how people used visual materials. She proceeded to tell me a story about a poster contest going on in her department in which the Master's students created conference-style poster presentations of their current research. She had overheard some faculty members who were examining one of the posters comment that it must have been done by one of the female students because it was so colorful and so artistic. She found this statement ironic since the poster they had been examining had been designed by a male student.

I found this story interesting for a number of reasons. First, it highlights the way in which people identify and use social identities, an important aspect of rhetorical status. Second, it shows that outside of the boundaries of my study, people do, in fact, attempt to determine the gender of creators of professional
documents on the basis of their visual design. Third, the story highlights the fact that many times these gender identifications are wrong. In my study, however, many of the raters were able to determine the gender of diagram designers with a good deal of accuracy; that fact is worth examining.

In this section, I examine the accuracy of the identifications raters made in this study. I discuss the role that androgynous and undifferentiated gender played in those identifications. Then I suggest some avenues for further research in this area. Finally, I conclude this section with a brief discussion about why it is critical to begin research into gender and visual communication with the issue of how accurate people are in their gender identifications.

Accuracy in gender identifications

Haswell and Haswell (1995) note that in the portion of their study in which the gender of the student author was not given, two-thirds of their evaluators spontaneously attempted to identify the author's gender. More than half of the time, their gender identifications were wrong. In my study, the 24 raters made 528 separate gender identifications. Of those 528, the raters were accurate 372 times, for an overall accuracy percentage of approximately 70 percent. (Of the accurate ratings, 56 percent were made by raters in Group 1 who saw the handwritten text; 45 percent were made by raters in Group 2.) They were more accurate identifying male designers than female designers, perhaps because some of the raters tended to use the male rating as the default, unless, as rater A said, there "was something that made me guess female."

Some of the raters were reluctant to answer the question about gender. Rater A, in fact, chose to mark male with a certainty rating of 1 on all but three gender choices because she did not feel she could identify the gender of the
designers solely on the basis of their diagrams. However, when I told her during the interview portion, after she had explained her responses, that exactly half of the designers had been female, she was visibly surprised, which indicated to me that she might have felt somewhat better able to judge their gender than her ratings had indicated. Rater 3 was also reluctant to judge gender. He did select either male or female, but he put very low certainty ratings on almost every one. However, in talking about his reasons for selecting male or female, it was quite clear that he had fairly strong reasons for his decisions and could point out individual elements of the diagrams on which he had based his selections. A number of other raters expressed discomfort at being asked to identify the gender of the designers, remarking that they were using "stereotypes," or "biases," or that they were going by "gut feelings" or "random guesses." The overall accuracy of the ratings indicates that contrary to what they indicated as their reason for discomfort, that it was difficult to tell the gender of the designers based on the diagrams, the raters were able to make gender identifications that were quite accurate.

Haswell and Haswell argue that "gender abhors a vacuum" (p. 249), that evaluators in their study were "compelled . . . to gender the writers" when no gender was identified for them (p. 232). This argument matches well with Arliss' (1991) statement that "we are largely preoccupied with dividing the human race into males and females" (p. 2). Raters in my study did not make gender identifications spontaneously as did the evaluators in Haswell and Haswell's study. However, the accuracy that the raters in my study showed would seem to indicate that a lifetime of making, usually spontaneous, gender identifications
led to fairly accurate identifications in this study, even when they felt uncomfortable in making the identifications.

Rater 9's story about the poster contest, with which I began this section, highlights the importance of understanding the identifications that people do make. If people, upon looking at a diagram, either implicitly or explicitly identify the gender of the designer, that identification might have some impact on how they interpret or respond to the diagram. Rater 9 continued her story by noting that the man who had created the poster display that the professors thought was done by a woman eventually placed third in the competition. Rater 9 indicated that she was unsure whether the fact that the professors thought it had been done by a woman or the fact that the student who created it was in his first year of graduate school had led to his not placing higher.

Androgynous and undifferentiated gender identifications

The idea that viewers of a visual item must "gender" the designer is complicated by one aspect of my study, the group gender scores that indicated that some designers might be better labeled "androgynous" or "undifferentiated" rather than male or female. Of the 48 gender scores among the two groups of ratings, 12 fell into the -8 to 8 range of androgynous or undifferentiated gender. This actually equates fairly well to the approximately 30% of individual gender identifications that were inaccurate—apparently about a quarter of the designs were difficult to place on a binary gender scale. Of the 12 gender scores that fell into this androgynous or undifferentiated zone, 7 were androgynous (scores either spread evenly across the continuum or clumped at both ends) and 5 were undifferentiated (clumped in the middle of the continuum).
Unfortunately, because the gender scores developed in my study are compilations of individual ratings of gender, rather than conscious selections of “androgynous” or “undifferentiated” by individual raters, it is difficult to factor them into the other analytical aspects of this study. There is some reason to believe that for some of the raters, a - score indicated either an androgynous or undifferentiated gender selection. For example, rater F indicated that a - meant he simply couldn’t make a determination, that the gender could go “either way.” However, as described above, rater A used the - as a default rating to show her discomfort at making the determination, not necessarily to identify a separate group of designers for whom gender was an unanswerable question. Rater C explained that she wanted to mark “didn’t know,” but that wasn’t an option. Because of these conflicting explanations about using the - score, I am reluctant to make any claims about what androgynous or undifferentiated gender might mean in terms of the effect of gender on visual communication in my study. The existence of this group of scores in the middle of the gender continuum in this study, which matches fairly closely Unger and Crawford’s (1992) statement that “in research using large samples of college students, roughly one-third can be classified as androgynous” (p. 52), should provide issues for further research.

Further research in gender identification

Identifying androgynous and undifferentiated gender is just one aspect of further research suggested by the results of this study. Another area would be the spontaneous identification of gender as suggested in the research of Haswell and

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7 As described in Chapter 3, raters in Group 1, who used the original diagrams, are identified by the numbers 1 through 12. Raters in Group 2, who used the modified diagrams, are identified by the letters A through L.
Haswell. In my study, raters were required to make gender identifications. This creates a somewhat artificial activity, in that we don't often have to write down the gender identifications we make when looking at visuals in professional documents. A study that tracked the spontaneous gender identifications of viewers would provide an interesting comparison. The problem involved in such a study, of course, is that our gender identifications usually are often implicit and so might remain hidden in any study that did not require participants to make them explicit.

An additional area for further research would be to place this study in a workplace context, to elicit or detect gender identifications made in the reading of professional documents in the workplace, for example. A poster session such as the one identified by rater 9 or at a professional conference might provide one such context. This kind of contextualized study would avoid the laboratory nature of the study that I've completed and would also highlight the actual implications that gender identifications might have in professional communication.

Understanding when people make gender identifications and how consistent and accurate those identifications are is the first step in understanding both performance differences and perceived differences in gender and visual communication. As Logue and Miller (1995) indicate, this is a critical aspect of rhetorical status, the identification of social roles on which rhetorical status is based. Until we know whether people make gender identifications, we cannot know whether they perceive male and female performance differently, whether they assign differential rhetorical status on the basis of gender. By the same token, unless we know when people perceive difference and whether or not
those perceptions are accurate, we cannot know what to look for in terms of actual performance differences that exist in the visuals people create. For this reason, understanding the gender identifications made by viewers of visual materials in professional communication is the most fundamental task involved in this research.

**On what basis do raters make their determinations of designer gender?**

The second issue I attempted to examine in this study was the basis on which raters made their often accurate gender identifications. This issue is no less critical in understanding both actual performance and perceived gender-based differences in visual communication than is the examination of the accuracy of gender identifications. Logue and Miller (1995) argue that social identities carry “expectations. Typical patterns of behavior are expected of the persons who fit these social types or classifications” (p. 26). These expectations have an important function in creating rhetorical status. The gender typing that raters exhibit in this study, with its accompanying expectations for behavior, helps explain the other evaluations they made concerning the diagrams.

Research has indicated that perceptions of gender-appropriate behaviors can change over time. Fecteau, Jackson, and Dindia (1992), in their study of “current perceptions of masculine and feminine traits” (p. 17), found that some traditional traits have remained fairly constant in being typed as masculine or feminine while other traits have changed over time. They see this as an indicator that our society may be more egalitarian now than it has been. The results of this portion of my study, however, indicate that there are a number of stereotypes about male and female drawing abilities and preferences that have not changed and have not diminished. While some raters did note that the
traits on which they based their gender identifications could be possessed by both men and women, the majority of raters held very traditional views of which drawing behaviors belonged to men and which to women.

**Traditional stereotypes in male and female communication**

Haswell and Haswell (1995) identify a number of traditional stereotypes about males and females. These stereotypes were held by the participants in their study, who

evinced a familiar set of gender stereotypes, simplistic cultural assumptions about differences between the sexes [genders]. They used this set most openly when we asked them to identify clues in the text supporting their best guess of the author’s sex [gender]. Their use tended to be highly traditional and highly polarized. (p. 233)

According to the participants in the study by Haswell and Haswell, male writing was “rough and pointed ... formless and unfocused ... preoccupied with ideas, linear, and ‘abstract’ ... they expected males to write just to finish the assignment” (p. 233). Female writing, on the other hand, was “‘fluid,’ ‘tempered,’ ‘subtle,’ and ‘soft’ ... well organized and clear ... detailed and ‘observant’ ... females ... write out of interest in the assignment” (p. 233). These stereotypes about male and female writing match other perceptions, some that have been empirically examined and some that have not, about males and females.

Art and design research has identified a number of perceptions concerning male and female design abilities and preferences that are important for understanding the results of my study. As Buckley (1989) describes the stereotypes, women traditionally have been thought to be “dexterous, decorative, and meticulous ... naturally suited to ... the so-called decorative arts” (p. 253).
The anecdotal evidence supports Buckley's assertion. The attitude Anderson (1980) attributes to Henry Frost, the early twentieth-century landscape architect, that women "paid more attention to detail" (p. 41) matches Buckley's description, as does Adams' (1993) study of the women of Canton Boo who are assigned to work only with decorative art. More generally, women have traditionally been thought to be sensitive, indirect, and emotional, while men are thought to be direct, aggressive, and rational (Arliss, 1991).

Some of the stereotypes I have described here are specific to communication studies or to art and design, and some are more general. However, almost all of these stereotypes were mentioned by the raters in my study as traits indicative of male and female design behaviors.

**Design stereotypes in the raters' gender identification traits**

The list of traits provided in Chapter 4 gives some indication of the stereotypes raters used to identify the gender of the designers in my study. That list included the following items:

- artistic style/ability
- handwriting
- technical knowledge/content
- neatness
- detail
- linearity
- simplicity
- pretty
- organization
- nice
- textual content

Simply looking over this list in light of the stereotypes described above can show how closely these traits are tied to traditional stereotypes of males and females in
our society. In this section, I discuss these traits, explaining more completely how they were connected to gender identifications by the raters, which traits were seen as male and which as female. In order to keep this discussion organized, I group some of the traits together into larger categories:

- handwriting—Since it represented such a large number of references, it seems fitting to deal with it separately.

- style—This includes artistic style, drawing ability, angular and rounded images, neatness, simplicity, pretty, and nice.

- content—This category includes technical knowledge/content, detail, and textual content.

- organization—This includes linearity and organization.

The names I have given to these categories are based on comments made by raters and the terms that the raters used. As a result, they are technically imprecise. I chose to use these terms in an effort to capture what the raters said, rather than to categorize raters' comments under more technically correct labels. Each of these traits involves very traditional stereotypes about male and female behaviors. In addition, each of these traits also involves important implications for understanding the role of perceived gender in visual communication.

_Handwriting_

At first glance, handwriting seems both very different from the other traits—it is a much more specific behavioral item than the others—and somewhat trivial; handwriting seems to be at most a very minor part of an individual's repertoire of behaviors. To begin this section, I discuss what the raters identified as male and female aspects of handwriting and the amount of influence handwriting had on gender identifications. Next, I discuss the potential importance of handwriting in professional communication studies.
Finally, I describe some potential implications for further studies based on the issue of handwriting as it developed in this study.

Raters who mentioned handwriting in both groups were very consistent in their descriptions of male and female handwriting styles. Males used capital letters, smaller point sizes, messier writing, and more angular letters. Females used rounded letters, larger point sizes, mixed upper and lower case letters, and were generally neater than males. An interesting aspect of these descriptions of handwriting styles is their similarity to the gender stereotypes described above. Like female compositions, female handwriting, as described by the raters, is curvy, more fluid, more connected, as well as “precise,” “flourishy,” and “more thoughtful.” The connection between handwriting and drawing styles was made explicitly by two raters in Group 2, who did not even see the handwriting on the diagrams. Rater G commented that “when men and women write, men are more vertical and horizontal, women are more curves. They draw like that, too.” Rater K stated that “the artwork [in one of the diagrams] screams female to me. . . . curvy, you can compare it to stereotypical handwriting. You don’t find males with loopy, curved writing.” Rater L noticed the connection between handwriting and gender identification when he said, “Good thing you removed the handwriting” while explaining his gender identifications.

Raters apparently based their perceptions of handwriting on their own experiences. Rater 12, a male, identified handwriting as female because it was “too neat—I have really messy handwriting.” Rater 9, a female, identified handwriting as male because “it looks like someone’s writing I know who is a male.” Other raters were leery of making gender identifications based on handwriting precisely because of their own experiences. Rater 6 identified the
female writing style but then said, “I might be wrong, Shawn [a male friend] writes like that.” Rater 5, who had altered her own writing because she worried about the gender effect, said she had male and female friends who write in the “male style.” In spite of being somewhat guarded about determining gender on the basis of handwriting, all 12 of the raters in Group 1 used handwriting to some degree in making their gender identifications, indicating that in the context of this study, handwriting represented a powerful gender cueing device.

Handwriting was so powerful that even when it wasn’t available for analysis (in Group 2 ratings) projections about what it might be like still had some influence on decisions.

The importance of handwriting was evidenced by two raters in this study. Rater 5, a female doctoral candidate in chemistry, indicated in the interview portion of the study that she had thought about handwriting and gender issues before. She based virtually every gender identification on the writing in the diagrams, only occasionally using drawing styles or other features. After explaining her responses, she went on to tell me that whenever she had to hand write a note to anyone in her department, she always tried to make the handwriting look masculine. It was part of a strategy, she explained, to not have her work dismissed as being feminine in a male-dominated environment. Rater G described an opposing experience. Her fiance, she said, has very feminine handwriting, so feminine that she has him handwrite notes for her to people. While in school, this handwriting was a source of embarrassment. When he forgot to put his name on papers, teachers would hold it up for the class and say, “I have a paper here without a name on it. It looks like a girl’s handwriting.” He then had to choose between the public embarrassment or losing grade points.
These stories illustrate the power of gendered handwriting in the experiences of the raters.

When handwriting first began to appear as an issue in this study, I was hard pressed to determine its importance for professional communication. The ubiquitous nature of computers in professional communication would seem to make handwriting a moot issue. However, the stories raters related about their own experiences with handwriting, as well as the two anecdotes I described earlier about handwriting in the engineering graphics textbook and in the O.J. Simpson trial, highlight the fact that handwritten text is still used and in important workplace contexts. DeKay and Freyd (1991) underscore this fact when they argue that “deciphering handwritten script is a task that most of us undertake on a daily basis” (p. 377).

If handwriting serves as an important cue about gender, and if gender identifications are important in making judgments about documents or designers (as I will argue it is later in this chapter), then handwriting is an issue worth investigating in more depth. In addition, there might be a connection between handwriting styles and font selection for document designers. Studies have already indicated that fonts are connected to stereotypes people have about professions and about other people (Walker, Smith, and Livingston, 1986). The same type of judgments raters made about designer handwriting might also be made about font selections that seem related to those handwriting stereotypes. The font I replaced the handwriting with was Geneva, a fairly common sans serif font often used in documents created in technical fields. Had I replaced the handwritten text with a more rounded font with serifs and flourishes, the Group 2 raters’ judgments might have been influenced on some of the diagrams. These
are all issues for further research. The potential implications of a seemingly trivial matter like handwriting make the issue of gendered traits in visual communication worth further investigation.

*Style*

Artistic style in this study represents a fairly large category of responses, all of which refer to the manner in which drawings were completed. The style or manner in which drawings were completed was mentioned as a justification for gender identifications by all but two raters in the two groups. That makes it the most common of the trait categories, even more common than handwriting. As with handwriting, the descriptions of male and female artistic styles sound very similar to the gender stereotypes described above. They are somewhat less polarized, however, in that some attributes were identified as both male and female by different raters, indicating that these particular traits might be seen in individual or idiosyncratic ways. In this section, I explore the descriptions of the various aspects of style, discuss their significance for professional communication, and end with a discussion of suggestions for further research.

Rater 9 argued that there is no way that you can tell male or female just by looking at drawings. Rater E, on the other hand, began the interview portion of the study by saying “there are some way masculine things” in the diagrams. The second of these comments indicates the more widely held belief among raters in this study. The vast majority of the raters identified a number of drawing traits belonging to male and female designers. One frequent, but often unexplainable, comment about diagrams identified as female-designed was that they exhibited a “female way of presenting things.” When pressed, raters who made this comment would often say, “I don’t know, it’s just a gut feeling I have.” Some
would explain by saying it looked like something a mother, sister, or female friend would have drawn.

More specific rater comments indicated that female-designed diagrams were "neat," "pretty," "creative," more attentive and careful, "more art-based rather than information based," "picture-oriented," "curved," and "decorative." Male-designed diagrams were, according to the raters, "aggressive," lacking in detail, technically detailed, "choppy looking," and text- rather than image-oriented. Raters' comments about detail indicate a very specific distinction between perceptions of male and female drawings. While female designs were generally labeled as more detailed, they were also criticized for lacking detail, but only when it came to technical information. Including technical details was a masculine trait, while decorative or artistic details were considered feminine. For example, rater 4 noted that a female included "a lot of detail" on a drawing of a package in a design, while rater 10 indicated that a male "would have put a lot more detail in the truck" drawing in one design. When males lacked detail, as rater B suggests, it is because they do not have "concern for doing a good job." When women lack detail it is because they don't understand the technical matters involved, as rater K indicated when she said "a male would give more detail on the rotation directions, a female wouldn't." One of the most common, and perhaps important, stereotypes that developed from the interviews was that women generally are seen as more interested in art, better at drawing, and more image-oriented or more visual than men.

Like handwriting, many raters developed their stereotypes about artistic style from their own experiences. Comments describing the source of these perceptions included the following:
rater D: "This is a bias from people I work with."
rater G: "Every guy I went to school with would have drawn . . . like that."
rater 3: "That's how I would have drawn it."
rater 10: "I have four children, two boys and two girls, all of whom love to
draw and I've seen the gender differences in my own kids' drawings."

Some of the raters mentioned that their perceptions were based on research that they had completed or material that they had read or seen in the mass media. Raters believe, generally, that they are making legitimate generalizations on the basis of their personal experience, either the drawing that they themselves do or the drawing they've seen others do. At the same time, many of them are willing to admit that these are stereotypes and biases that they hold, and a number of the raters even became uncomfortable as they watched their biases unfold in the comments they made. Rater 10 provided an excellent example when she said, "I'm seeing my own gender bias and I'm not comfortable with it." However, she then went on to make the comment attributed to her above about her four children. As did all of the raters who mentioned discomfort about their own stereotypes, rater 10 was able to employ the stereotypes in spite of her discomfort.

The most important implication for professional communication in these stereotypes about men and women and their approach to design style is the idea that differences in how men and women are perceived as designers might affect how men and women progress and perform in the field. Art and design provide an important example of how perceived differences in ability can affect training and opportunities. If women are perceived as being good at decorative, non-information based drawing, then they might be pushed into areas of professional
communication where those attributes are valued most highly, such as designing promotional materials. If men are perceived as being better at information-based or technical design, then they might be encouraged or supported in more technical design areas. As visual communication becomes more and more important in professional communication, these differences might become more pronounced.

The engineering poster contest story illustrates the way in which stereotypes about gender traits, in this particular case the use of color and decorative design features, can potentially effect the rewards people receive in their training and work. As rater J, a female chemical engineering doctoral candidate, explained, “In engineering everybody tries to label you in that [gender] stereotype—you’re good at this or that.” As visual communication becomes a more commonly accepted attribute of technical individuals, stereotypes about visual abilities will become more prominent. Rater 5 suggested that learning to create visual presentations of technical information was an important aspect of graduate study in chemistry. This might suggest that perceived differences in technical design ability could become gatekeeping devices—stopping people from pursuing degree programs because they feel unable to learn the appropriate designing style.

Studying the ways in which the perception of design abilities affects people’s career choices would be one area of study suggested by the results of this study. The raters provided sufficient anecdotal evidence about the importance of perceptions of gender-based differences in stylistic issues to warrant such research. In addition, a great deal of further research could be done to examine the kinds of perceptions about gender-based stylistic differences held by people in
different disciplines and at different levels or positions within those disciplines. Such research could involve identifying attitudes among professional information designers and among professors of information design. Similar studies could be carried out using academics and professionals from the disciplines represented by raters in this study—genetics, chemistry, engineering, agronomy, journalism and mass communication, and human development and family studies—as well as graphic design and the many other fields in which professional and visual communication are important. Studies that investigate more specifically how people develop stereotypes about gender-based artistic styles would be useful, as well. An examination of the way in which boys and girls are schooled in art might be revealing in that respect. Further investigation might document how even college-level courses in document design, graphic design, computer-aided design might contribute, explicitly or implicitly, to the idea that males and females have different stylistic approaches to design.

Perceptions by raters that males and females exhibit different stylistic preferences in the diagrams used in this study are closely aligned with traditional stereotypes about male and female communication patterns and artistic performance. These stereotypes, judging from the anecdotal and research evidence, have persisted for many years. The comments from raters in this study indicate that not only do these stereotypes persist, but they may, in fact, be related to differential judgments about people working in a wide variety of disciplines. The stylistic traits identified by raters in this study—artistic style, neatness, image versus information orientation, simplicity—seem to be potentially strong sources of differential judgments of male and female
performance in professional communication. That potential seems to warrant
further investigation of this issue.

\textit{Content}

As mentioned above concerning technical detail, raters in this study
identified content differences as a trait they used to identify the gender of the
diagram designers. The amount of technical content diagrams possessed
appeared, to the raters, to indicate whether the designer was male or female;
more technical content generally indicated a male designer, while less technical
matter indicated a female designer. This perception seemed to be based on two
separate perceptions: one, that more males than females are involved in
technical fields at the Iowa State University, where the diagrams designers were
students; two, that males were more interested in and more knowledgeable
about technical details and content than were females. In this section, I detail
these two different perceptions as evidenced by the raters comments. I then
suggest potential implications of these perceptions for professional
communication.

A number of raters identified gender differences in technical content as
being a matter of preference, interest, or knowledge on the part of the designers.
Rater A, for example, identified one designer as female because she “took time to
draw a seed . . . she wants to draw a seed and not machinery.” Rater 2,
commenting on a female identification, said “there was a lack of detail in the
pictures, she wasn’t sure what the press looks like.” Rater 10 suggested that a
“male would have . . . put in more detail on the truck,” a suggestion matched by
rater K, “figured a male would give more detail on rotation directions, female
wouldn’t.” One rater, F, a doctoral student in human development and family
studies, indicated that his perception was based on his own research in which "technical is male, creative is female." Other raters were careful to indicate that their perceptions of male and female differences in technical content were based on the demographics of Iowa State or of technical fields in general. Rater 5, a chemistry doctoral student, claimed that "there are more male students in technical fields" and so "I identified whether they were technical or not first, then I identified gender." This description of her process did not seem entirely accurate, however, since I observed her making gender selections first, even though it was the third item on the questionnaire, for many of the diagrams. Other raters, however, echoed her perception about demographic odds: Rater 7, "it was pretty technical and most technical majors are male"; and rater D, "more men in technical areas, so more detail or more written out means male."

This area of perception seems most clearly connected to larger stereotypes about male and female preferences and backgrounds, stereotypes that can to some degree be justified on the basis of demographic studies, as some raters suggested. Of course, the problem involved is that of self-perpetuation: "knowing" that males are more likely to have experience in, be trained in, or be interested in technical areas allows males to receive more support for these endeavors. For females, of course, it would work in just the opposite fashion; they would be encouraged away from technical areas because "that's not what women are interested in." The issue of experience is an important one in terms of visual ability, as indicated in Chapter 2. A number of studies indicate that both perceptual and drawing abilities are affected by the differences in experiences allowed men and women, boys and girls in our society. The fact that some of the raters making judgments about females not being experienced or
interested in technical fields were themselves female shows how complicated the issue can be. Even those people who have "broken through" these stereotypes are still reluctant to give them up. And, as with other traits, raters noticed that they were using stereotypes and called attention to their own biases, as did rater F when he began a comment with "Being a male chauvinist . . ."

Organization

Overall organization of the diagram was another trait raters identified as gendered. Linear diagrams were perceived as indicating a male designer while less linear diagrams were perceived by the raters as indicating a female designer. Three drawings, in particular, stood out to raters as examples of male and female organizational preferences. Two diagrams, numbers 8 and 22, were conventional flow charts, both oriented vertically, beginning at the top of the page and moving down. (Photocopied versions of the original diagrams can be found in Appendix C.) They used arrows and boxes to contain and order the text and to orient the reader. Both were described by raters as being male designed because they were extremely linear; as one rater described flow chart organization, it consisted of "straight lines, straight down." Diagram 14, a large sunflower centered on the page with small stylized icons surrounding it in a circle, was described as female-designed because it was circular. Raters were correct in identifying the gender of these designers—diagrams 8 and 22 were created by males and 14 was created by a female. This matches Bosley's (1992) conclusions. Bosley, using what she identifies as feminist theory, connects linear thinking with masculine, logical thought and circular thinking with feminine, relational thought, a connection that rater I implied when he said, "It's [a flow chart diagram] more of a logical presentation."
Raters connected linearity and circularity with other gendered attributes. For example, rater 2 suggested that a circular organizational pattern was "artistic," and, therefore, female. This rater also indicated that linearity equated with technical background, noting that "technical people use flow charts, lines." Rater 12 suggested that linear organization and art were incompatible when he said, "More linear, less art."

The equation of linearity with male designers was not always consistent. Rater J identified a lack of linearity as a source for her identification of a diagram as male-designed. She said, "It's how a guy draws it. The order goes all over, goes from one side to the other then down." Her comment suggests that a lack of neatness or orderliness, much as with drawings and handwriting, equated to male design, regardless of the linearity of the overall layout. The perception of linearity as a masculine concept and circularity as feminine occasionally existed despite the raters' own experiences. Rater G, for example, identified diagram 14 as female because "the flower in the middle and circular structure are feminine." At the end of the interview, however, rater G, who is female, said, "I'm a real linear person." As with other stereotypes, even individual raters who violated them still saw the stereotypes as useful indicators of gender in the study.

The rater-identified sources of stereotypes about male and female organizational preferences were interesting. Two raters, 6 and 10, both suggested that media and academic attention to male and female modes of thinking lead to their perceptions. Rater 6—who said, "I associate linear designs with masculine attributes"—identified the "American media" as the source of this stereotype. Rater 10 suggested that the public emphasis on this gender-based difference had actually confused her own thinking: "Sometimes that's [flow chart diagram] a
male way of thinking. I've read and heard that so much I don't know what I think. That could be a learned trait, too.” Interestingly, both of these raters were from Human Development and Family Studies, and both indicated that studying gender traits had been part of their academic training. These comments suggest the possibility that gender studies might reinforce stereotypes as much as they mitigate them.

The connections drawn between technical background, logical thinking, linearity and male organizational patterns represents an important set of implications for the use of visuals in professional communication. These connections seem to indicate that what is perceived as masculine organization is more valuable than organizational patterns perceived as feminine. While organizational patterns described as female—circular patterns or more zig-zag designs—were often seen as attractive, they were not described as being logical or technical in nature. (This phenomenon is discussed in more detail under the “Visual Appeal” section below.) This differential evaluation establishes an important understanding for designers—linear organization might be seen as more technically astute. Further research might examine whether the relationship works in reverse, whether diagrams identified, either by the participants or by the researcher, as female are seen as less linear or less logical in their organizational pattern.

The differences in valuing between male and female traits by raters in this study parallel much of Logue and Miller’s (1995) discussion of social status as it influences rhetorical status. Logue and Miller note that classifications based on social identity can determine the degree to which individuals like, esteem, or value other individuals. In addition, Logue and Miller argue that “rankings on
some sets of graduated parameters have a direct or inverse correlation with others,” a concept they refer to as “status generalization” (p. 26). As parties bring an “array of characteristics that are potentially significant” to a communicative interaction, other participants select those characteristics that will be salient in making judgments of rhetorical status in the particular interaction (27). In the case of raters in this study, it appears that traits associated with gender are connected to a number of other traits that the raters either value or devalue in particular contexts.

**Do the traits identified by the raters as leading to their gender identifications positively correlate with those identifications?**

The fact that gender writing scores and the use of replica images are correlated with gender scores in a statistically significant way and that angled corner percentages and word-to-image ratios are approaching significance indicates that there is some validity to the explanations the raters gave for their gender identifications. That not all of the traits correlated with the gender scores does not mean that the raters were wrong or misleading in their justifications of their gender identifications. The lack of correlation could indicate that the measures I applied in each area were not sensitive enough to identify what might be subtle differences or my interpretations of the raters' explanations were incorrect. Flannery and Watson (1995) encountered a similar phenomenon in their study of artistic ability among children, noting that their measures of artistic skill “did not specifically include judgments of representationality or visual complexity which could be more sensitive to sex [gender] differences” (p. 120). While I attempted to account for some of what Flannery and Watson
thought was missing from their measures, the measures I used might still have been insufficiently sensitive.

The lack of correlation between trait scores and gender scores might also indicate that the post hoc, stimulated recall interviews did not allow raters to provide a completely accurate or thorough account of their decision-making processes; perhaps they had already forgotten the many factors that might have been involved. Or, the lack of correlation may simply indicate how tremendously complex gender identifications are, requiring individuals to factor in more cues than they may even be aware of. Arliss (1991) explains that the gender expectations individuals hold for other people are often unconscious and therefore surprising even to the holder. Each trait that raters mentioned would provide avenues for further research in which the characteristics could be refined and made more sensitive and then applied in a variety of contexts. The evidence indicates that the traits as I identified and tallied them in the diagrams do not completely explain the gender identifications that raters’ made throughout the study. This provides an important issue for future research in this area to continue trying to identify exactly how people make their determinations of the gender of designers and writers.

How do determinations of gender correlate with other evaluations of the diagrams, such as effectiveness, visual appeal, or designer knowledge?

Of all the perception issues, the relationship between gender identifications and other evaluations might have the most important implications for visual and professional communication. Even if it is accepted that viewers of visual items determine or pay attention to the gender of the designer, that fact makes no real difference unless that attention leads the viewer
to interpret or use the information differently. Logue and Miller (1995) explain that participants in a communicative interaction can possess a number of characteristics, only some of which are perceived as salient in a given interaction. Every person can, Logue and Miller suggest, “potentially be classified in multiple ways” (p. 25). Gender might, then, simply be ignored, even though individuals feel they can readily identify it, unless the communicators feel it is an important variable. On the other hand, some characteristics “for example, gender or race or occupation—can overwhelm the others in [their] salience for our interactions” (p. 25).

The results from this part of the study indicate that some important considerations about the process diagrams are apparently attached in some way to the raters’ identification of the designers’ gender. Specifically, raters in this study were more likely to view a diagram as visually appealing if they also thought that the designer was female. Similarly, the raters were more likely to think the designer had less technical background or knowledge if they thought the designer was female. These correlations are worth considering in more detail in an effort to understand how the raters evaluated visual appeal and technical background and how those two characteristics could be attached to gender. Effectiveness, on the other hand, was not correlated with either male or female identifications.

In this section, I discuss the raters’ views of visual appeal and technical background in a way that highlights their connection to gender identification. I then provide a possible explanation for the lack of correlation between effectiveness and gender. After that discussion, I end the section with a brief
look at some potential implications of the correlation of gender and visual appeal and technical background for professional communication.

**Visual appeal**

The previous discussion of gendered traits indicates that the style of the drawings was strongly equated with gender by the raters. An examination of the descriptions raters provided of diagrams they found appealing and unappealing shows that those gendered traits carry into other evaluations, as well. A review of the raters' comments reveals three elements in visually appealing diagrams: attractive, eye catching drawings; an immediate impression of the process being drawn; an easy-to-follow pattern or flow. Each of these three elements can be equated with female traits identified by the raters. Their opposites, the characteristics of unappealing diagrams, can be equated with male traits.

Many of the raters described the drawings in visually appealing diagrams with words that sound very much like the descriptions used of drawings completed by designers raters identified as female. As raters described visual appeal, appealing drawings were "nice," "neat," "attractive," "detailed," "pretty," "creative," "artistic," "cute," and "ornate." Unappealing drawings, on the other hand, were "messy," "cramped," "small," "tiny," "incomplete," "cluttered," and "undescript." It is worth noting that raters' descriptions of unappealing drawings appear to be much more definitive than do descriptions of appealing drawings. These two sets of terms could very easily be transposed with the terms used to describe the reasons raters gave for their gender identifications. The more drawing ability, neatness, and care for quality work that was shown in the diagram, the more likely it was to be viewed as visually appealing and to be
identified as female-designed. The messier, more cramped, and less thoughtful a
diagram, the more likely it was to be viewed as unappealing and male-designed.

The use of images itself was part of the criteria of many raters for visual
appeal. Raters commented that diagrams that “relied heavily on pictures” or
“used graphics for each step” were more visually appealing. By the same token,
diagrams without images were likely to be seen as unappealing: “more writing
and not very visual is unappealing,” “couldn’t just be words, that turns people
off,” and “no pictures equals not appealing.” These characteristics, too, tie into
earlier descriptions of females as being image-oriented and males as being text-
oriented. They also tie into the results found in the quantitative analysis, where
males used many more words than images while females used almost equal
numbers. As rater 3 explained, it was the “combination of words and pictures”
that made for the most visually appealing diagrams, and that criteria seems to
favor female designers.

The overall impression criteria, also, seemed to favor descriptions of
female visual behaviors more than males. In the gender identification portion
of the interviews, women were said by rater C to “see a big picture as opposed to
detail-by-detail.” Similarly, rater B indicated that female designers had a
tendency to pay “attention . . . to the entire project.” This perception of females
places them in the more visually appealing category in terms of the raters’
evaluations. Males, however, were seen as focusing on more minute, technical
details, such as hinges on buckets and door handles and text on trucks. This
attention to technical detail seems to work against the necessity of providing the
overall image of the entire process that the raters looked for in visual appeal
ratings.
Organization seems to be more complicated than either drawings or overall impressions. Linearity, which raters identified as a male trait, was prized by a number of raters as an aspect of visual appeal. At the same time, other raters commented that strictly linear flow charts were "boring" and not "attention grabbing." What raters seemed to mean by linearity in talking about visual appeal (as opposed to the apparently more narrow, traditional meaning applied in talking about male and female drawing styles) was a logical, clear, easy-to-follow placement of the diagram on the page. Raters stated that diagrams had to "flow," "neatly partitioned" into steps or stages, be "easy to follow," not be "too cluttered," and be "designed for the eye." Rater 7's comment about the flow of one appealing diagram indicates that linearity in the sense of being a straight line was not as important as being easy to follow: "The way it 'swoops' down—it's nice visually, the design rolls like a roller coaster." As rater 10 suggested, female designers have "a better sense of proportion" on the page, and it is this aspect of perceived female design that seems to equate female with visual appeal in this study.

Technical Background

As indicated above, the technical background rating and gender were closely connected. Some raters went so far as to say that they made gender decisions based on the demographics of technical fields: there are more males than females in technical fields, so a technically astute diagram was probably created by a male. Other raters indicated that they generally believe females to be less technically knowledgeable than males, a stereotype that goes beyond academic demographics. Rater E made the technical/masculine connection
explicit when he said, "It's more male-oriented—it looks like an engineer did it."

Because technical knowledge seems to be an important part of rhetorical status in professional communication, particularly in technical communication, it seems worth exploring the connection between technical background and gender in more depth. Comments made by raters about technical background that reveal the connection with gender can be divided into four categories: the use of detail, the use of visual versus verbal material, creativity, and organizational patterns. In each of these areas, the raters' comments about technical background match very closely comments made about gender identifications.

**Use of detail**

Raters were consistent in indicating that detail was a major feature of designs created by people with technical backgrounds. Raters looked for detail in both the drawings and the written text. A "lack of detail" was one of the most common justifications for a non-technical rating. However, they appeared interested only in certain types of detail in determining technical background. As might be expected, raters looked for detail that revealed technical knowledge. Particular items raters mentioned included temperatures, rotational arrows and other conventional drawings, chemical formulas, and mechanical features of equipment. This reliance on technical detail seems to match with explanations of gender identifications which also emphasized detail. As described above, female-designed diagrams were seen as possessing detail, but that detail was not viewed as technical. This same distinction occurs in evaluations of technical background.
Visual versus verbal

Females were generally seen as being more visually-oriented than males in this study. Similarly, designers with non-technical backgrounds were viewed as being more visually-oriented. Designers with technical backgrounds included explanatory text. Technical designers were described as being “descriptive,” as “providing explanations,” and as providing “lots of information.” Non-technical designers, on the other hand, “relied on pictures,” lacked “explanatory words,” and paid “more attention to visual appeal” than to information. This dichotomy is reminiscent of the idea described earlier that female drawings are image-oriented rather than verbal and informational. In this study, non-technical designers are artistic, but their overall diagrams lack informational content. As rater 8 described a non-technical design, it had only “a minimal amount of information.” A lack of words was identified by rater A as an attempt “to get around ignorance of the terminology.” The use of images in diagrams became, for some raters, a method for disparaging diagrams: “it’s more visual than explanatory . . . an arts and crafts type of thing,” and “they’re just using a picture.” Some raters made art and technical background mutually exclusive. Rater F described one diagram as a “graphic representation rather than technical.” Rater 6 stated that “art, by definition, is non-technical.”

Raters did see some visual elements as technical in nature. If images provided technical details—machinery, conventional symbols—then raters were likely to identify the designer as having a technical background. If these types of drawings were combined with verbal explanations of processes or equipment, then raters were very likely to identify the designer as technical. Combinations of words and images, provided that the wording was concise and the images
technically detailed, were identified as most indicative of technical training. However, words alone, in the two flow charts, were identified as indicating technical backgrounds, also. It seems that the raters' identification of visual orientation as a female trait and verbal orientation as a male trait establishes categories that place males in technical backgrounds and females in non-technical backgrounds.

**Creativity**

Creativity was another gender-identified trait that raters used to identify technical and non-technical designers. Creativity was, in much the same way as artistry, identified as a non-technical characteristic. Diagram 14, with the sunflower placed in the center of the page, elicited a number of comments about creativity. Rater H described that diagram as "an interesting concept, but you don't see that among engineers." Rater B described it as "a unique way of looking at the process, which is artistic and non-technical." Rater B's comment reveals the complexity of ratings of creativity, and the potential contradictory nature of these evaluations. While discussing diagram 18 (see Appendix C), which shows animated sunflowerseeds jumping into the various pieces of equipment, rater B said, "It's unique . . . the designer would have to know what's going on," so the designer must have a technical background. Uniqueness in diagram 14, however, indicates an artistic approach that is non-technical. Apparently, creativity was combined with other traits, such as technical detail, in making determinations about technical background. This phenomenon might have held true for creativity as a gender trait, as well.
Organization

As described above, linear organization was seen as masculine and circular organization was seen as feminine. A similar dichotomy occurs in the technical/non-technical ratings. Linearity is described as a technical trait, while circularity is described as a non-technical trait. This appears to be a more narrow conception of linearity than was evidenced in the examination of visual appeal ratings. In discussing visual appeal, raters who used the term linearity often seemed to mean that a diagram was orderly. However, in discussing technical backgrounds, raters seemed to use linearity as being similar to a flow chart diagram, oriented straight down the page.

Rater H, an engineering major, explained why many raters saw flow charts and similar linear process depictions as typical of people with technical backgrounds when he said, “It uses a pure block diagram. That’s drilled into your head in technical courses.” Other raters described similar reactions to the flow chart, noting that the kind of segmented, linear thinking flow charts represent is highly valued in technical programs. Circular diagrams, particular diagram 14 with its sunflower center, were seen as specifically non-technical. Non-technical diagrams were described as “circular” and their designers as “somebody who thinks in round terms, artistic.” Rater F highlighted the distinction between the flow charts and the circular sunflower diagram when he identified a design as having a technical designer: “It’s a flow, a process, it’s not a picture of a sunflower.”

Bosley (1992) argues, based on feminist psychology theory, that rounded or circular shapes might be related to female psychological preference for nonhierarchical, circular thought patterns and male preference for hierarchical,
linear patterns. Linear thinking is considered more rational. The connection raters draw between linear presentation and technical background might be based upon similar reasoning. If linear thinking is perceived as more rational and more logical, it might also seem more appropriate to technical disciplines. Circular orientations, therefore, would seem to belong to non-technical disciplines. The connections might work in multiple directions: (1) women are perceived as being non-linear thinkers and women work in non-technical fields; therefore, those fields must be non-linear; or, (2) technical fields are linear, non-technical fields are not; since women are non-linear thinkers, they are likely to be in non-technical fields.

**Effectiveness**

Effectiveness seems more difficult to understand than either visual appeal or technical ratings because the findings are less clear. No statistically significant differences appeared in the effectiveness ratings of male-identified or female-identified diagrams. There are at least two ways that this lack of difference might be explained. First, effectiveness might have been a more open-ended category for raters than was visual appeal or technical background. Visual appeal, as the previous discussion indicates, seems inherently connected with issues of gender since artistic expressions seems to be a gendered trait. Technical background, also, seems gendered in that demographically women are fairly consistently underrepresented in technical fields; the raters were well aware of that fact. Effectiveness might not have carried any such connections for the raters, and so their ratings might have been more bias-free than they were for other traits.

A second explanation might work along almost opposite lines of reasoning. Raters tended to think of effectiveness in two ways. Some raters saw
effectiveness as technical accuracy and content. This definition of effectiveness would tend to favor male designers based upon the other stereotypes that were found. Other raters saw effectiveness as visual appeal and attention-getting. This definition seems more in keeping with what raters identified as female traits in other ratings. This explanation would suggest that because raters were working on one or the other definition of effectiveness, their scores would differ in ways that might eliminate any clear gender connection.

This second explanation seems somewhat more satisfactory. The stereotypes evidenced in other ratings seem too compelling and too potentially connected to issues of effectiveness to assume that effectiveness might have been bias-free. In addition, since many raters suggested that visual appeal and effectiveness were related, the significant gender connection of visual appeal ought to have made some impact on effectiveness ratings. Perhaps what is occurring is the dichotomy between visual appeal and informational content that has been discussed above. Visual appeal alone is insufficient to make a diagram effective. At the same time, informational content alone is also insufficient. Because male and female designs are perceived as emphasizing one, often at the cost of the other, ratings for both sets of designs are evened out.

Implications for professional communication

Raters in this study seem to maintain fairly consistent divisions between male and female traits when rating technical background, visual appeal, and effectiveness. Females are perceived as designing appealing diagrams that are low in technical content. Males are perceived as designing unappealing diagrams that contain more technical detail. This difference might keep both groups from being seen as developing effective diagrams. The task for which
designers were asked to create their diagrams, a process diagram to be distributed to the general public, requires a conscientious handling of both visual appeal and informational content, as would many designs used in professional communication. Trained designers are taught to manage both aspects, to make diagrams that serve the multiple functions required by the design context. However, if students of professional communication view each of those elements is perceived as belonging to a different gender, as the raters in this study seem to, it would be difficult to help them become truly effective visual communicators.

In addition, it would seem possible that audience reactions might be similar to those of the raters. If a design seems too information-laden, it might be perceived as uninviting and unappealing. On the other hand, if a design was seen as being too "artistic," too appealing, it might be perceived as lacking in informational content. Logue and Miller (1995) argue that rhetorical status can "affect our receptivity to what is said by opening or closing our minds to the message and even by filtering its contents" (p. 22). The extent to which gender identifications suggest ways of "seeing" the diagrams in this study suggests that gender had some sort of filtering effect on the raters. These possibilities would seem important for visual communicators to understand as they create diagrams.

Along similar lines, it might be more important in some disciplines, those in which information is seen to be at a premium, to use design elements that emphasize the technical information contained in the design. Raters identified content-specific and conventional design elements as being more technical. These design elements might need to appear in greater proportions when a
designer seeks to develop technical credibility. Logue and Miller (1995) note that rhetorical status is never static, that it changes as contexts and situations change. Characteristics that might lead to low status in one situation, such as attractiveness in this study, might lead to high status in another. Designers might need to be made aware of the way in which socially-inscribed preferences for design practice need to be monitored and altered in accordance with communication situations. There are important implications for both creating designs, especially process diagrams for the various audiences, and for training visual communicators in the ratings of technical background, visual appeal, and effectiveness in this study.

**Limitations and potential of this study**

Before I summarize what I see as some of the most important results of this study, it is worth noting some of the limitations involved in the methods I have used as well as some of the potential for further research arising from this study. In this brief examination, I divide the limitations into three areas: participants, raters, and analysis. After discussing these limitations, I make some suggestions for further research that might refine and build upon this study.

**Limitations**

Most of the limitations of this study are a result of its exploratory nature. I originally intended this study to raise at least as many questions as it answered. Primarily, I hope that this study will encourage others to examine the issue of gender and visual communication. Researchers who do so might want to design studies that overcome some of the limitations faced by this one.
Participant limitations

The student designer participants in this study were all native English speaking, undergraduate students, at a midwestern U.S. technical university. These characteristics bring limitations. There was no attempt to examine the role that ethnicity might play in creating visuals. Neither was there an attempt to examine a more diverse group of academic majors, including art and design, professional communication, education, or humanities. Different majors would be expected to provide different training as well as to attract individuals with different backgrounds. This study does not provide insight into how diverse majors might affect visual communication.

Next, the nature of the task participants completed limits the generalizability of the results of this study. Because participants created only rough drafts of the diagrams, this study does not examine how finished products might or might not be affected by gender. Some of the results, such as the identification of “messy” elements, might be altered dramatically if more finished drafts of the diagrams were used. The same would hold true if students had been allowed to use computers to create the diagrams rather than doing them by hand. Finally, and perhaps most importantly, because the designers were all students, this study does not identify the potential effects of workplace practices on visual communication behaviors. Because much of the current research in visual communication emphasizes the importance of conventions for visual production and interpretation, it is important to note that the student designers did not have any extensive training in the visual conventions of the places in which they hope to work once they graduate from college.
Rater limitations

Like the student designers, the raters in this study were all graduate students. Some of the raters had workplace experience and others did not. This is a limitation on the generalizability of the raters' reactions just as it is for the designers' behaviors. In addition, the raters represent only six academic disciplines. Because disciplinary conventions are important in visual communication, these raters represent only a small slice of potential perspectives on issues such as effectiveness and visual appeal as well as gender perceptions.

Not only were the rater characteristics important, but the kind of involvement the raters had in the study was limited. Raters were able to provide some commentary about the perceptions that they exhibited in their evaluations of the diagrams. However, that commentary came after the fact, and so represented only a post hoc view of the traits on which they thought they had based their evaluations. This method might not elicit the most accurate results for trait analysis. Finally, I did not attempt to have the raters comment on my interpretations of their responses. This limited the amount of input they had into what is described in this report of the study.

Analysis limitations

The final area of limitations that I think is particularly important concerns the types of analysis I used. First, I focused in this study on only two portions of the communicative interaction: the designers' gender and the raters' perceptions of the designers' gender. A more sophisticated analysis might be accomplished by analyzing not only how designer gender affected the outcomes, but also how rater gender affected the raters' reactions. Second, the trait analysis I performed was based on a fairly small number of traits. There might be additional traits not
examined in this study that could lead to more conclusive findings about gender's affect on visual communication. Finally, some of the ratings, particularly effectiveness, were problematic for raters. Raters had different definitions for some of the terms used in the questionnaires, and this affected the results as indicated in the discussion of the correlation between gender and effectiveness ratings.

**Potential for future research**

I think that the results of this study, as well as its limitations, establish a firm basis on which to conduct future research. The first kind of research that ought to occur would be replication with other groups of participants like the designers and raters in this study. This could serve as a useful extension of the findings of this study. Various modifications could be made in the replications, such as using revised or computer-generated drafts, which would identify how the methods I employed might have encouraged particular results. Next, research that moves this study into workplace contexts would be especially useful. The anecdotes supplied by the raters, such as the story of the engineering poster contest in which judges were guessing the gender of a poster designer, suggest that some of the results of this study might be identifiable under workplace conditions. Studies that could examine how gender is involved in the creation of documents in the workplace would provide insight into whether what is identified in this study is nothing more than a "school" effect.

Another area for further research would be to use more specific measures of gender. Rather than relying on simple self-reports from the designers, gender could be measured using one of the available standard tests for gendered self-concept. These results could then be compared to design practices to provide
more in-depth understanding of how gender operates in these contexts. In addition, raters could be asked to make finer distinctions, including identifying androgynous and undifferentiated genders. Studies will need to be developed that compare rater gender with both gender identifications and perceptions of design practices. Such studies would provide a much more detailed understanding of how the gender of all participants in a communicative interaction work together in the formation of rhetorical status. Finally, one variation of this study that would be particularly useful would be a study that examined spontaneous identifications of gender, either in naturalistic settings or in controlled conditions. Such a study would provide much more insight into whether and when people make gender identifications.

This study is designed to serve as a springboard for further research. The potential research I have identified here represents only a few of the possibilities that might be developed from both the methods I have used and the results I have described. There are two specific things that future research ought to build on from this study: one, gender is a variable worth investigating in studies of visual communication; two, methods that yield insight into both the performance differences that might occur in visual production because of gender as well as the perceptions that are triggered by gender will be the most useful for understanding gender as a variable in visual communication.

**In conclusion: Gender, visuals, and professional communication**

The concept of rhetorical status proves useful in explaining how gender operated in both the creation and evaluation of the diagrams used in this study. As a socially constructed identity, gender appears to have prompted some specific
differences in the creation of diagrams by male and female designers. These differences then served as cueing devices for the raters, allowing them to justify, whether accurately or inaccurately, social typing and ranking of the diagram designers. Based on the gendered typings, raters developed perceptions about other aspects of the diagrams, including their appeal and effectiveness, and about the designers, specifically their technical background. Logue and Miller (1995) argue that rhetorical status "is a communicative identity that affects my way of addressing others and my way of receiving what others communicate to me" (p. 21). While this study does not examine how the raters might have "addressed" the designers, because the study situation did not require a response from the raters directed to the designers, it seems to provide ample evidence that the gender identifications raters made affected the way they received what the designers communicated.

The results of this study provide a number of important implications for the study, practice, and teaching of visual communication within professional communication. First, the study provides a specific example of how the concept of rhetorical status works in a professional communication environment, providing some initial support for Logue and Miller's (1995) contention that "it is through assignment of rhetorical status . . . that the communications of particular persons, in particular contexts, gain or lose efficacy" (p. 20). Rhetorical status, based on its usefulness in this study, might be useful in pursuing other issues in professional communication.

Second, the study identifies important issues for consideration in visual communication practices. The results of this study suggest that gender might play a role in shaping designer's preference in creating visual materials in
professional communication contexts. Designer gender also apparently influences how people perceive visual communication elements, linking various valued and devalued attributes to designs and communicative interactions. These effects seem important for professional communicators who use visual materials in their documents, a group that includes more and more communicators as visuals are recognized as remarkably influential in communication. These results can help professional communicators evaluate the ways rewards might be distributed differently and the ways people may be encouraged to pursue various avenues in professional communication because of gender-related issues, much as has been identified in art and design (see, for example, Buckley, 1984/1985, 1989, 1994).

Third, the results of this study suggest issues for teachers of professional communication and visual communication to consider. Gender has been identified as a relevant variable in teacher responses to student compositions (see, for example, Haswell and Haswell, 1995). The results of this study establish the possibility for similar effects in teacher responses to visual elements of professional communication documents. In addition, the results of this study suggest that attention might need to be paid to gender-related student design preferences and the rhetorical statuses that might be created by those preferences in specific communication situations.
REFERENCES

_African Arts_ October, 32-43

Adler, R.B. & Rodman, G. (1991) _Understanding human communication._  
Chicago: Holt, Rinehart, and Winston.


These instructions were provided orally for the students who designed the sunflowerseed oil extraction process diagrams used in this study.

Today, for our class activity, I would like you to participate in a research project that I am involved in. The research concerns how prior knowledge affects a particular writing task; in other words, how what we already know affects a part of the technical writing process. I will ask you to complete three items: a brief written description of a process, a short drawing task, and then, on Wednesday, a short survey.

Because this research project is not directly related to our class, you are not obligated to participate. Choosing not to participate will have no bearing on your grade for this class. If you do not want to participate, you are welcome to work on other things during this time. I do ask, though, that you not disturb the people who are participating. Your participation, however, will be very helpful for me and will improve the quality of the results of this research.

Prewriting Task:

In front of you is a lined piece of paper. On that paper, I would like you to write everything you know about the process of extracting oil from sunflower seeds. Include the process, equipment, and materials, and be as thorough as you can in the time you are given. I would like you to take 5 minutes to complete this portion of the project.

Drawing Task:

Now that you have completed the writing task, I am going to give you another task. This portion of the project involves creating a visual representation of the sunflower seed oil extraction process. I am going to hand out a written description of that process, along with instructions for the visual representation I would like you to create. Please read the instructions, and complete the task described there. Use the plain white paper for this portion. If you need more paper, a pencil, or other material, or if you have questions about what you are to be doing, please raise your hand and I will come around and help you. I cannot answer questions about the process or your visual representation, however. You have the remainder of the class period to complete this portion of the process.

When you are finished, please let me know and I will give you a permission sheet to read and sign.
APPENDIX B: WRITING PROMPT GIVEN TO STUDENT DESIGNERS

The written description on the following page is a copy of the writing task and the sunflowerseed oil extraction process that was provided to the students who designed the diagrams used in this study.
Description

Most modern sunflowerseed processing plants begin processing by drying and then dehulling, or decorticating, the sunflowerseed because a higher value meal can be obtained by removing sunflowerseed hulls. Seeds being processed should be clean of debris and have a low moisture content. Decortication is a process in which the seeds are separated into hulls and kernels. The seeds are then mechanically pressed between a moving rotor and a stationary plate. A screen separates the cracked hulls from the meats. Some plants use a new air dehuller in which seeds are blown against a cracking surface and an upward air stream separates hulls, dehulled kernels, and uncracked seeds based on the differing weights of the components.

The next step in processing, the flaking process, follows whether the seeds are dehulled or not. The seeds are first heated to between 180 and 240 F (68 to 101 C), further lowering the moisture content; they are then pressed through large rollers into flattened flakes breaking open the seed cells and making the oil more accessible. Actual oil extraction occurs in a mechanical press. These continuous feed devices use a screw press operation to press oil from the heated flaked cake. The remaining oil is then chemically extracted.

The solvent extraction stage washes the pressed cake with a hexane-based solvent in a large holding basket. The solvent washes the cake, allowing oil to leach out of the cake and combine with the solvent. The hexane solvent is an extremely volatile substance and must be completely removed from both the oil and the remaining cake before it can be recovered and reused.

The resulting crude sunflowerseed oil is then bulk packaged and shipped to refiners for further processing into edible oil products.

APPENDIX C: STUDENT-DESIGNED DIAGRAMS

The following diagrams are photocopies of the original sunflowerseed oil extraction diagrams created by students for this study. Some of the diagrams have been reduced from their original size to meet margin requirements for binding.
1. Hulls are opened by the presser plate cracking them so decortication can take place. Once cracked open, seeds can fall through the screen to separate from hulls.

2. The seeds are dried by an oven to remove moisture.

3. The seeds are then flattened by rollers to make the oil easier to get.

4. The oil is then extracted by a mechanical press.

5. Further extraction utilizes solvents.
1. Drying
2. Decortication
3. Pressing + Separation
4. Heat seeds to 180°C
5. Oil extraction
6. Solvent washing
7. Solvent removal

Solvent reacts with the natural solvent, this separates the oil + solvent.
MODERN SUNFLOWER SEED
OIL EXTRACTION PROCESS

WHOLE SEEDS

Drying & Descertulating (includes single extraction or degumming method)

DEGUMMED KERNELS

Heating & Pressing (includes single extraction or screw press method)

PRESS EXTRACTED OILS

Solvent Extraction (short duration or vacuum process)

REMAINING OIL

Processing & Shipping

DEGUMMING: Separating the kernel (meat) from the shells

HEATING: Further removes moisture

PRESS: USED TO EXTRACT OIL

Solvent: USED TO WASH REMAINING OIL OUT OF CAKE. SOLVENT EVAPORATES QUICKLY, LEAVING OIL BEHIND
THE EXTRACCIÓN OF SUNFLOWER SEED OIL

SEEDS ARE FIRST CLEANED OF DEBRIS AND ARE THEN DRIED.

SEEDS ARE THEN DEHulled OR DECOATED; THE PROCess BY WHICH THEY ARE SEPARATED INTO HULLS AND KERNELS.

NEXT, THE SEEDS ARE PRESSED AGAINST A SURF ace WHICH SEPARATES THE OIL FROM THE KERNELS.

SEEDS THEN GO THROUGH THE FRESHING PROCESS:
1) HEATED TO 110-240°F

2) PRESSED THROUGH ROLLERS WHICH FLATTERN THEM INTO CACKS.

A SCREW PRESS PRESSES THE OIL FROM THE CACK. REMAINING OIL IS CHEMICALLY EXTENDED.

CRUDE SUNFLOWER OIL IS BULK PACKAGED AND SHIPPED TO REFINERS FOR FURTHER PRODUCIION.
Drying + Dehilling + Separating + Heating = Seed Oil

Breaking + Extracting + Washing = Sunflower Seed Oil

A perfect packaged product
Seeds are dried

Hulls are removed and separated

Seeds are heated to 180-200°F (80-100°C)

Seeds are smashed between rollers

Seeds are mechanically pressed to extract oil

A hexane-based solvent is used to extract the remaining oil

Solvent is removed from seed "cake" and oil

Crude sunflower oil is sent to refining plant
1. Drying
2. Pressing
3. Flaking
4. Bulk Packing & Shipping

Sunflower Oil
Diagram of a process:

1. Clean seeds → Dry seeds → Dehydration process
   - Stationary plate
   - Moving plates

2. Seeds in oven → Screw press → Oil extracted

3. Solvent on pressed seeds → Oil mixture → Oil on pressed seeds
   - Must be completely solvent free

4. Oil shipped to refinery for further processing
Heat to 180-200°F

Final crude oil
Shipped to refinery for further processing
1. Seeds
2. Air Dehuller
3. Oven
4. Rolling
5. Pressing

Seeds are blown against a cracking surface. An upward air stream pushes the light hulls up while the heavier kernels fall down.

Corns

The seeds are dried to remove moisture. Drying time varies based on the type of seeds.

the seeds are pressed between large rollers to break open the seeds. This leaves the oil not accessible.

A mechanical press is used to free the oil from the seed cake. The extracted oil is ready to ship.

6. Chemical Extraction

The seedcake remaining, the pressing, is mixed with hexane, for removing oil mixed with the hexane and left from the seed cake.

Oil and Hexane are separated. The hexane is reused while the oil is ready to ship.

Packaging. The oil from the pressing and chemical extraction is combined, packaged and shipped to refiners for further processing into edible oil products.
THE SUHAROEE OIL PROCESS...
START HERE

1. HARVEST
2. WASHING
3. DRYING
4. DECORTICATION
   - Hulls
   - Seeds
5. FLAKING
6. HEATING TO LOWER MOISTURE CONTENT (130°F-240°F)
7. MECHANICAL PRESSING
8. PRESSED CAKE
9. OIL
10. TO BULK PACKAGING
Seed comes from dryer & falls on conveyor which rolls under some rolls & at the end of the conveyor the fall into sifting 8 screens that sort out shells from kernels.

Then seeds placed onto large plates & then roll into oven 68-100°C

Then remain oil oil removed by chemicals

All oil taken to refinery
1. Drying Seeds

2. Decortication
   (Separate hulls from kernels)
   - H = Coarse Hulls
   - D = Kernels
   - U = Uncollected Seeds

3. Flaking
   - 200°F
   - C = Kernels
   - B = Broken Kernels

4. Solvent Extraction Stage
   - Convex solvent
   - EX: Mechanical press
   - O = Pressed Oil
APPENDIX D: STUDENT DESIGNER QUESTIONNAIRE

The questionnaire on the following page was distributed to the students who created the sunflowerseed oil extraction process diagrams used in this study.
Survey

Purpose  This survey is designed to gather information that will aid me in analyzing the visual representation you completed in the previous portion of this project. As with all parts of this project, you are under no obligation to answer any of these questions; however, responding to all of these items will improve the results of my study.

Demographic Information
Age __________  Major ______________________________________
Gender__________  Year in school______________________________
Type of Current Employment (if any) ____________________________

Knowledge Information
Please respond to the following items as thoroughly as possible. Use the back of this page if you need extra space for your response(s).

1. How much experience did you have with the sunflower seed oil extraction process prior to completing the drawing task? (Circle one.)

   1  2  3  4  5
   None  Some A lot

2. Did you have any experience with all of this process? Yes_____ No_____  
   If so, what was the process and where did you get this experience?

3. Did you have any experience with parts of this process? Yes_____ No_____  
   If so, what was the process and where did you get this experience?

4. Did you have any experience with all or part of a similar process?
   Yes_____ No_____  
   If so, what was the process and where did you get this experience?

4. Have you ever seen a diagram like the one you created? Yes_____ No_____  
   If so, where did you see it?
APPENDIX E: MODIFIED STUDENT-DESIGNED DIAGRAMS

The following diagrams are modified versions of the 22 student-designed diagrams I created for use with Group 2 raters. To create the modified versions, I scanned the original diagrams using Photoshop® on a Macintosh® computer. I then replaced the original handwritten text with computer-generated Geneva text that matched the original text in size, placement, and content. No other modifications were made to any of the diagrams used in the study. Some of the diagrams have been reduced to fit the binding requirements of this dissertation.
1. Hulls are opened by the pressor plate cracking them so decortication can take place. Once cracked open, seeds can fall through the screen to separate from hulls.

2. The seeds are dried by an oven to remove moisture.

3. The seeds are then flattened by rollers to make the oil easier to get.

4. The oil is then extracted by a mechanical press.

5. Further extraction utilizes solvents.
1. Drying
2. Decortication
3. Pressing & Separation
4. Heat seeds to 180-240°F
5. Oil Extraction
6. Solvent Washing
7. Solvent Removal

Solvent reacts with the washing solvent. This separates the oil & solvents.
Kernals on top of screen

Hulls below screen

Conveyor belt

180-240°F

Waste

Oil and solvent

Pressed seeds

Remove Solvent

Package the oil

Hexane based solvent
MODERN SUNFLOWER SEED
OIL EXTRACTION PROCESS

WHOLE SEEDS

DECRISTICATING: SEPARATING THE KERNAL (MEAT) FROM THE SHELLS

DROPPING & DECORTICATING
(INCLUDE SIMPLE DRAWING OF DECORTICATING MACHINE)

DESSHELLED KERNALS

HEATING & PRESSING
(INCLUDE SIMPLE DRAWING OF SCREW PRESS WORKING)

PRESSED KERNAL CAKES

SOLVENT EXTRACTION
(SHOW DIAGRAM OF WASHING PROCESS)

REMAINING OIL

PACKAGING & SHIPPING

HEATING: FURTHER REMOVES MOISTURE
PRESS: USED TO EXTRACT OIL

SOLVENT: USED TO WASH REMAINING OIL OUT OF CAKE. SOLVENT EVAPORATES QUICKLY, LEAVING OIL BEHIND
THE EXTRATION OF SUNFLOWERSEED OIL

SEEDS ARE FIRST CLEANED OF DEBRIS AND ARE THEN DRIED.

SEEDS ARE THEN DEHULLED, OR DECORTICATED, THE PROCESS BY WHICH THEY ARE SEPERATED INTO HULLS AND KERNELS.

NEXT, THE SEEDS ARE PRESSED AGAINST A SCREEN WHICH SEPERATES THE HULL FROM THE KERNELS.

SEEDS THEN GO THROUGH THE FLAKING PROCESS:
1) HEATED TO 180-240 °F
2) PRESSED THROUGH ROLLERS WHICH FLATTEN THEM INTO CAKES.

A SCREW PRESS PRESSES THE OIL FROM THE CAKE. REMAINING OIL IS CHEMICALLY EXTRACTED.

CRUDE SUNFLOWER OIL IS BULK PACKAGED AND SHIPPED TO REFINERS FOR FURTHER PROCESSING.
DRYING + DEHULLING + SEPARATING + HEATING

BREAKING + EXTRACTING + WASHING

SUNFLOWER SEED OIL

A PERFECT PACKAGED PRODUCT
sunflower seeds (just harvested) & some debris

- cleaned dried
- moving rotor stationary plate
- cracks open seeds
- OR
- hulls (light)
- projects seeds w/force onto cracking surface
- meat (happy)
- source of air
- screw press
- seeds flattened into flakes
- oil extraction
- flakes pressed into cake
- washed w/ hexane
- hexane washes cake
- oil & hexane
- oil & removal
- crude oil

edible oil

heat (68 - 101°C)

decortication (separating hulls & kernels)

* preferred step but optional

(sunflower)

extraction.

(continued below)
seeds are dried

hulls are removed and separated

seeds are heated to 180-240°F (60-101°C)

seeds are smashed between rollers

seeds are mechanically pressed to extract oil

a hexane-based solvent is used to extract the remaining oil

solvent is removed from seed "cake" and oil

crude sunflower oil is sent to refining plant
1. Drying

3. Flaking

3. Solvent Extraction Stage

4. Bulk Packing & Shipping

Sunflower Oil
CLEAN SEEDS → DRY SEEDS → HEAT LAMPS → OVEN → SEEDS DEHULLED OR NOT

T = 180 - 240°F

ROLLERS

STATIONARY PLATE

MOVING PLATES

SOLVENT

PRESSED SEEDS

WASHES THE PRESSED

SOLVENT & OIL MIXTURE

PRESSED SEEDS

OIL & OIL EXTRACTED

MUST BE COMPLETELY SOLVENT FREE

OIL

SHIPPED TO REFINERS FOR FURTHER PROCESSING
Water wash

Seeds

Dryer

Air blown on seeds to dry after wash

Pressure

Heater

Heat to 180-240°F

Furnace

Rollers

Roll on seed masses

Rollers

Flatten seed masses

Screw press

Hexane-based solvent

Wash off solvent

Screw press

Oil collection

Strainer

Remaining cake

Collect solvent for reuse

Final crude oil

Shipped to refiner for further processing
Seeds are blown against a cracking surface. An upward air stream pushes the light hulls up while the heavier kernels fall down.

The seeds are dried in an oven to reduce their moisture content. Drying oven temp: 180-240°F (88-101°C)

The seeds are pressed between the rollers to break open the seeds. The leaves the oil more accessible.

A mechanical press is used to force the oil from the seed cake. The extracted oil is ready to ship.

The seed cake remaining from pressing is mixed with hexane. The remaining oil is mixed with the hexane and skim from the seed cake. Oil and Hexane are separated. The hexane is reused while the oil is ready to ship.

The oil from the pressing and chemical extraction is combined, packaged and shipped to refiners for further processing into edible oil products.
SEEDS ARE HARVESTED
AND SHIPPED OUT.

THE SUNFLOWER OIL PROCESS...

SEEDS ARE HARVESTED
AND SHIPPED OUT.

THE SUNFLOWER OIL PROCESS...

THE SUNFLOWER OIL PROCESS...
Sunflower "Seed" → DECORTATION → Hull → Mechanical Processing → Kernal → Heat → Press Rollers → FLAKES → Chemical Processing → hexane → holding basket of flakes and cake → oil & solvent leached out & separated → To Refinery → oil & solvent leached out & separated → To Refinery
Dehulling

Kernel

Dehulling

Rotor

Stationary plate

Press kernels

Screen separates hulls from meats

Heat between 180 to 240°F

Press used in oil extraction

Remaining oil extracted w/ chemicals

Packaged & shipped
1. Take the oil and run through a large oven heated to 180°-240°F.
2. Use a large press to break the hulls.
3. Go through a screen to sift out the hulls.
4. Run the mixture through large rollers.
5. Separate the solvent and oil using a screw press.
6. Presses out oil.
7. Package it.
HARVEST → WASHING → DRYING

DECORTICATIN

HEATING TO LOWER MOISTURE CONTENT (180°F-240°F)

MECHANICAL PRESSING

PRESSED CAKE → OIL

TO BULK PACKAGING
PRESSED CAKE

HEXANE-BASED SOLVENT

HOLDING BASKET

!!! CAUTION !!!

EXTREMELY VOLATILE

SOLVENT EXTRACTION

HEXANE SOLVENT

OIL

TO BULK PACKAGING

TRASH

18B
oven

seed come from dryer & fall on conveyer which rolls under some rolls & at the end of the conveyer the fall into sifting screens that sort out shells from kernals.

oven 68-101°C then seeds placed onto large plates & then roller goes over them.

then remain oil all removed by chemicals

all oil taken to refinery
& mechanical extraction

Separation Process

raw seed → dryer → seed de-hulls → Jet dry → seed kernal → roller crusher

heated pressurized air

seed hulls

Kernal & hull are together

roller crusher

jet at right velocity that lifts hulls but insufficient to lift kernals.

hulls → screw press → compressed mass → chemical extraction of remaining oil

kernals → oil

Chemical extraction Process

Solvent bath

C_6 H_6 (hexane) → "oil less" solids

flattened matter → hexane "boiler" → crude sunflower oil

oil remains in hexane solvent
1. Drying Seeds

2. Decortication (separating hulls from kernels)
   - Cracked Hulls
   - Kernels
   - Uncracked Seeds

3. Flaking
   - 200°F
   - Kernels
   - Broken Kernels

4. Solvent Extraction Stage
   - Hexane Solvent
   - CAKE (From mechanical press)
   - Extracted Oil

- Extracted Oil
SUNFLOWER SEEDS

DRYING

OR

DEHULLING

SEEDS

HEATING

PRESS

180°-240°

PRESS

SCREW PRESS

CHEMICAL EXTRACTION

OIL

SOLVENT

SUNFLOWER SEED MEAL

PACKAGED

OIL

HULLS

CRACKED HULLS

MEATS

AIR DEHULLER

TO REFINERIES
APPENDIX F: VERBAL INSTRUCTIONS FOR LAY RATERS
IN GROUP 2

The following instructions were read to lay raters in Group 2. Group 2 raters evaluated the modified versions of the diagrams.

[Before reading instructions, give rater piece of note paper.]

I am going to give you 22 versions of a diagram of the sunflowerseed oil extraction process. Each design version was completed by a different person. For legibility purposes, I have scanned the original documents into a computer and replaced all handwritten text with typed text. You may notice some minor effects caused by the scanning. Please disregard those in your evaluations. For each design, I'm going to have you complete a questionnaire.

[Give rater copy of rater questionnaire.]

This is a copy of the questionnaire. [Point to items 1–3.] As you can see, the first 3 items ask you to make a determination about a characteristic of the designer. Each of those items also asks you about the certainty of your determination: In other words, how certain are you about the choice that you've made?

[Point to items 4 & 5.] The next two questions ask you to rate an aspect of the design itself.

Please complete all of the questionnaire items for one design before proceeding on to the next design.

After you have completed questionnaires for all of the designs, I will ask you some questions about particular designs. If you would like to make notes about any of the designs as you go, feel free to do so on the scratch paper I've provided. [Indicate note paper.]

One of the designs is on two sheets of paper that are paper-clipped together. When you get to that design, I’ll show you how the pages fit together.

[Give rater copy of design prompt.]

This is a copy of the prompt the designers used in creating the diagrams. Please take a couple of minutes to read through it.

[Wait until rater has finished reading.]

Do you have any questions? If not, here are the questionnaires. Each one is numbered. Those numbers correspond to numbers I’ve written in the bottom corner of each diagram. Here are the diagrams. You may begin.
APPENDIX G: DESCRIPTIONS OF RATERS IN GROUP 1 AND GROUP 2

The tables on the following pages provide descriptions of the raters in Group 1 and Group 2. Group 1 raters are identified by numbers 1-12; Group 2 raters are identified by letters A-L. The tables provide information about the following rater characteristics:

- Gender
- Age
- Major (or area of last degree completed)
- Year in School (or last degree completed)
- Current or past jobs
Table G.1. Description of lay raters in Group 1
Raters in this group evaluated the original diagrams.

<table>
<thead>
<tr>
<th>Rater 1</th>
<th>Female</th>
<th>27</th>
<th>Mass Communication</th>
<th>MS (completed)</th>
<th>Public relations for medical company¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rater 2</td>
<td>Male</td>
<td>30</td>
<td>Plant Breeding</td>
<td>Last year of PhD</td>
<td>Research assistant in agronomy</td>
</tr>
<tr>
<td>Rater 3</td>
<td>Male</td>
<td>31</td>
<td>Mechanical Engineering</td>
<td>1st year of PhD</td>
<td>Aerospace engineer for USAF</td>
</tr>
<tr>
<td>Rater 4</td>
<td>Female</td>
<td>32</td>
<td>Genetics</td>
<td>MS (completed)</td>
<td>Molecular geneticist with agricultural company</td>
</tr>
<tr>
<td>Rater 5</td>
<td>Female</td>
<td>28</td>
<td>Chemistry</td>
<td>Last year of PhD</td>
<td>Research assistant in biophysical chemistry</td>
</tr>
<tr>
<td>Rater 6</td>
<td>Male</td>
<td>27</td>
<td>Human Development &amp; Family Studies (HD&amp;FS)</td>
<td>2nd year of MS</td>
<td>Research assistant for Head Start staff development</td>
</tr>
<tr>
<td>Rater 7</td>
<td>Male</td>
<td>24</td>
<td>Journalism &amp; Mass Communication</td>
<td>2nd year of MS</td>
<td>TV news producer</td>
</tr>
<tr>
<td>Rater 8</td>
<td>Male</td>
<td></td>
<td>Genetics</td>
<td>PhD (completed)</td>
<td>Molecular geneticist with agricultural company</td>
</tr>
<tr>
<td>Rater 9</td>
<td>Female</td>
<td>24</td>
<td>Biomedical Engineering</td>
<td>2nd year of MS</td>
<td>Teaching assistant for computer-aided engineering course</td>
</tr>
<tr>
<td>Rater 10</td>
<td>Female</td>
<td>43</td>
<td>Plant Physiology</td>
<td>1st year of PhD</td>
<td>Research assistant in agronomy</td>
</tr>
<tr>
<td>Rater 11</td>
<td>Female</td>
<td>34</td>
<td>HD&amp;FS</td>
<td>MS (completed)</td>
<td>Resource teacher¹</td>
</tr>
<tr>
<td>Rater 12</td>
<td>Male</td>
<td>25</td>
<td>Organic Chemistry</td>
<td>3rd year of PhD</td>
<td>Research assistant in organic chemistry</td>
</tr>
</tbody>
</table>

¹ Two raters now work as full-time mothers. The jobs listed for them are the last jobs they held that were related to their academic degrees.
Table G.2 Description of lay raters in Group 2
Raters in this group evaluated the modified diagrams.

<table>
<thead>
<tr>
<th>Rater</th>
<th>Gender</th>
<th>Age</th>
<th>Major (or area of last degree completed)</th>
<th>Year in School (or last degree completed)</th>
<th>Current or past employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Female</td>
<td></td>
<td>Genetics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Male</td>
<td>24</td>
<td>Genetics</td>
<td>1st year of PhD</td>
<td>Research assistant in genetics</td>
</tr>
<tr>
<td>C</td>
<td>Female</td>
<td>26</td>
<td>Journalism &amp; Mass Communication (J&amp;MC)</td>
<td>2nd year of MS</td>
<td>Research assistant in J&amp;MC</td>
</tr>
<tr>
<td>D</td>
<td>Male</td>
<td></td>
<td>J&amp;MC</td>
<td>2nd year of MS</td>
<td>Teaching assistant in J&amp;MC</td>
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<tr>
<td>E</td>
<td>Male</td>
<td>31</td>
<td>Agronomy</td>
<td>4th year of PhD</td>
<td>Research assistant in agronomy</td>
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<tr>
<td>F</td>
<td>Male</td>
<td>33</td>
<td>Human Development &amp; Family Studies (HD&amp;FS)</td>
<td>2nd year of PhD</td>
<td>Teaching and research assistant in HD&amp;FS</td>
</tr>
<tr>
<td>G</td>
<td>Female</td>
<td>24</td>
<td>HD&amp;FS</td>
<td>3rd year of MS</td>
<td>Skills development specialist for family clinic</td>
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<tr>
<td>H</td>
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<td>25</td>
<td>Biomedical Engineering</td>
<td>2nd year of PhD</td>
<td>Research assistant in computer courseware</td>
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<tr>
<td>I</td>
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<td>29</td>
<td>Engineering Mechanics</td>
<td>4th year of PhD</td>
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<tr>
<td>J</td>
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<td>27</td>
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<td>3rd year of PhD</td>
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<td>K</td>
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<td>30</td>
<td>Environmental Toxicology (Agronomy)(^1)</td>
<td>3rd year of PhD</td>
<td>Research assistant in environmental toxicology</td>
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<tr>
<td>L</td>
<td>Male</td>
<td>26</td>
<td>Organic Chemistry</td>
<td>3rd year of PhD</td>
<td>Research assistant in organic chemistry</td>
</tr>
</tbody>
</table>

\(^1\) Environmental toxicology is an interdepartmental major within the Agronomy department at Iowa State University.
APPENDIX H: VERBAL INSTRUCTIONS FOR LAY RATERS IN GROUP 1

The following instructions were read to lay raters in Group 1. Group 1 raters evaluated the original diagrams.

[Before reading instructions, give rater piece of note paper.]

I am going to give you 22 versions of a diagram of the sunflowerseed oil extraction process. Each design version was completed by a different person. For each design, I'm going to have you complete a questionnaire.

[Give rater copy of rater questionnaire.]

This is a copy of the questionnaire. [Point to items 1–3.] As you can see, the first 3 items ask you to make a determination about a characteristic of the designer. Each of those items also asks you about the certainty of your determination: In other words, how certain are you about the choice that you've made?

[Point to items 4 & 5.] The next two questions ask you to rate an aspect of the design itself.

Please complete all of the questionnaire items for one design before proceeding on to the next design.

After you have completed questionnaires for all of the designs, I will ask you some questions about particular designs. If you would like to make notes about any of the designs as you go, feel free to do so on the scratch paper I've provided. [Indicate note paper.]

Two of the designs have pieces of paper stapled on them covering portions of the page. Those pieces of paper and the material under them are not part of the design. One of the designs is on two sheets of paper that are paper-clipped together. When you get to that design, I'll show you how the pages fit together.

[Give rater copy of design prompt.]

This is a copy of the prompt the designers used in creating the diagrams. Please take a couple of minutes to read through it.

[Wait until rater has finished reading.]

Do you have any questions? If not, here are the questionnaires. Each one is numbered. Those numbers correspond to numbers I've written in the bottom corner of each diagram. Here are the diagrams. You may begin.
APPENDIX I: LAY RATER QUESTIONNAIRE

The questionnaire on the following page was given to the lay raters in both Group 1 and Group 2. Some modifications have been made to the questionnaire to meet formatting requirements for this dissertation.
Visual Design Questionnaire

Design Number _____________

1. **Major**
   This author's major is: Technical ____ Non-technical ____
   
   Certainty: 1 2 3 4 5
   Very Uncertain Somewhat Certain Very Certain

2. **Education Level**
   This author is a/an: Undergraduate ____ Graduate ____
   
   Certainty: 1 2 3 4 5
   Very Uncertain Somewhat Certain Very Certain

3. **Gender**
   This author is: Male ____ Female ____
   
   Certainty: 1 2 3 4 5
   Very Uncertain Somewhat Certain Very Certain

4. **Visual Appeal**
   How visually appealing is this design?
   
   Certainty: 1 2 3 4 5
   Very Unappealing Undecided Very Appealing

5. **Effectiveness**
   How effective is this design?
   
   Certainty: 1 2 3 4 5
   Very Ineffective Undecided Very Effective
APPENDIX J: TABLES OF DIAGRAMS RATERS DISCUSSED IN INTERVIEWS

The tables on the following pages indicate the diagrams each rater was questioned about in the interview portion of the study. Prior to meeting with any of the raters, I randomly selected diagrams 7, 14, and 16 to be included in each interview to provide a standardized set of discussion items. While the raters completed the questionnaires for the diagrams, I selected three more diagrams to use in the interviews. These selections were based on the rater's responses to the diagrams.
Table J.1  Diagrams selected for discussion in interviews with raters in Group 1

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</tbody>
</table>

Note: Diagrams 7, 14, and 16 were randomly selected at the beginning of the study to be included in every rater's interview.
Table J.2 Diagrams selected for discussion in interviews with raters in Group 2

|       | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|-------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Rater A | X |   |   | X | X | X |   |   | X | X |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Rater B |   | X | X |   |   |   | X | X | X |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Rater C | X | X |   | X |   |   | X |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Rater D | X | X | X |   |   |   |   | X | X | X |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Rater E | X |   |   |   |   |   |   | X | X | X |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Rater F | X |   |   | X |   |   | X |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Rater G |   | X |   |   |   |   |   | X |   |   | X | X | X |   |   |   |   |   |   |   |   |   |   |
| Rater H | X | X |   |   |   |   | X |   |   |   |   | X | X | X |   |   |   |   |   |   |   |   |   |
| Rater I | X | X |   |   |   |   | X |   |   |   |   | X | X | X |   |   |   |   |   |   |   |   |   |
| Rater J | X | X | X |   |   |   |   | X |   |   |   | X | X | X |   |   |   |   |   |   |   |   |   |
| Rater K | X | X | X |   |   |   |   |   |   | X | X |   |   |   |   |   |   |   |   |   |   |   |   |
| Rater L | X | X |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

Note: Diagrams 7, 14, and 16 were randomly selected at the beginning of the study to be included in every rater's interview.
APPENDIX K: RAW DATA FOR GENDER IDENTIFICATION ANALYSIS

The tables on the following pages present the raw data used to derive the gender identification results presented in Chapter 4. An M in the tables means that the rater selected Male, an F means the rater selected Female. A + indicates the rater marked a certainty rating of 3 or higher, indicating at least some certainty; a – indicates a certainty rating of 1 or 2, indicating that the rater felt at least somewhat uncertain.
Table K.1 Group 1 lay rater gender identification responses

<table>
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<th>Design #</th>
<th>1</th>
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Table K.2 Group 2 lay rater gender identification responses

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