CASE STUDIES OF TECHNICAL REPORT WRITING DEVELOPMENT AMONG STUDENT ENGINEERS

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ABSTRACT

This research examines factors that either promote or hinder workplace writing among Chemical Engineering students during their study in two Technical Report writing courses. It examines the extent to which a workplace writing environment, which instructors believe they create, is actually enacted in the classroom, and also explores the differences in intended and actual learning outcomes between instructors and students.

A number of qualitative research methods were used to gather data for sixteen student case studies. These methods include taped and transcribed interviews with students and the two course instructors, an analysis of all student reports and course documentation, classroom observations, taped student-professor conferences, and taped responses from both instructors as they evaluated each student report.

Research findings suggest that students learned the required technical report format since everyone passed the course. Findings further suggest, however, that explicit efforts to enact a professional chemical engineering writing environment within this university context were generally unsuccessful. Writing tasks did not reflect an authentic workplace writing situation where writers believed their composing purpose was to communicate with others within their community of Chemical Engineering. Even though attempts were made by instructors to create such an environment, the writing task actually became a school-based exercise where students learned to provide the right textual format in order to meet with both teacher expectations and writing success.

The study concludes that educators must be aware of their real teaching and learning agendas and that these objectives must be conveyed adequately to students. Findings also reinforce the difficulty of enacting authentic workplace writing contexts within academic environments, and ways to achieve this goal are discussed. This research also contributes to evolving theoretical discussions about writing and the teaching of writing.

RÉSUMÉ

Cette recherche examine les facteurs qui favorisent ou gênent, chez les étudiants en génie chimique, l'acte de rédaction en milieu de travail dans le cadre de deux cours de rédaction de rapports techniques. Elle examine jusqu'à quel point l'environnement de rédaction au travail, que les instructeurs croient avoir créé, est réellement reproduit en classe, et explore aussi les divergences, entre instructeurs et étudiants, dans les résultats d'apprentissage attendus et constatés.

Plusieurs méthodes de recherche qualitatives ont servi à recueillir des données relative à 16 études de cas. Parmi ces méthodes, notons des entrevues enregistrées et transcrites avec des étudiants et les instructeurs des deux cours, une analyse de tous les rapports des étudiants et la documentation de cours, les observations faites en classe, des conférences étudiants-professeurs enregistrées ainsi que les réactions enregistrées des deux instructeurs à l'évaluation de chaque rapport d'étudiant.

Les conclusions de la recherche porte à croire que les étudiants connaissent les exigences de présentation de rapports techniques, puisque tous ont réussi le cours. Par contre, il semble que les efforts pour reproduire un milieu de rédaction professionnelle en génie chimique dans le contexte universitaire aient en général échoué. Les tâches de rédaction ne reflétaient pas une véritable situation en milieu de travail où les auteurs croient que le but de leurs composition est de communiquer avec leurs collègues en génie chimique. Même si les instructeurs ont tenté de reproduire un tel environnement, la tâche a fini par être un exercice didactique par lequel les étudiants apprenaient à fournir la bonne présentation en vue de répondre aux exigences du professeur et d'avoir les notes voulues.

L'auteur en arrive à la conclusion que les éducateurs doivent prendre conscience des véritables objectifs d'enseignement et d'apprentissage, et qu'ils doivent les transmettre aux étudiants d'une façon satisfaisante. On constate également la difficulté de recréeer dans le contexte universitaire les vrais conditions de travail et l'on discute des moyens d'atteindre ce but. La recherche apporte également une contribution à l'évolution des discussions théoriques sur la rédaction et l'enseignement de la rédaction.

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INTRODUCTION

As the study of composition has evolved to become an independent field of critical investigation and theoretical debate, commonly held perceptions of writing and textual production have similarly evolved over the past four decades. The field has now reached a point where many, perhaps most, theorists and researchers perceive writing as a social activity, and the texts produced in any given social context are shaped and determined by the conventions of that social environment. In other words, the elements writers must accommodate while composing, such as vocabulary, form, structure, and purpose, are shared conventions shaped by writers writing from the same contextual base.

Several researchers have explored how this shaping works as writers learn their craft in particular technical fields or professional groups. Studies of writers in their workplace (see, for example, Odell and Goswami, 1985; Winsor, 1990; Devitt, 1991; Paré, 1992a & 1992b; Ledwell-Brown, 1993) and writers in various academic disciplines (for instance Bazerman, 1985 & 1987; Faigley, 1985; Myers, 1985; Bazerman & Paradis, 1991) have been examined to determine how contextual writing conventions are acquired. Researchers have also examined student writers who, while learning many things in school, are also acquiring the composition knowledge of their academic, and probable future professional, discipline (for example, Parkinson McCarthy, 1987; Berkenkotter, Huckin, & Ackerman, 1988; Freedman, 1987 & 1993).

Fewer studies have been conducted to examine academic programs with courses designed specifically to teach novices the professional writing conventions of their field. This study is concerned with the technical writing of undergraduate students intending to

become chemical engineers. Specifically, this study examines several case studies of students enrolled in two Technical Report writing courses, the purpose of which is to teach learners how to write a technical report. Through analysis of the selected cases, the study provides insight into both developing writing ability and how educational institutions can assist students with learning the conventions specific to their chosen discipline.

This chapter briefly presents the theoretical underpinnings, research problem, general questions, and research methodology of this investigation. These sections are then developed more fully in the subsequent chapters of the thesis beginning with a review of the relevant theory and research in Chapter Two. In Chapter Three, the research setting is described, the research questions are developed, and the methodology followed throughout this investigation is outlined. Chapter Four presents a detailed analysis and discussion of the data collected, and Chapter Five concludes the study by examining the implications of the research findings for teaching and future research.

THEORETICAL OVERVIEW

Proponents of the social constructionist view of writing maintain that writers and their writing both shape and are shaped by the social environment and language context wherein composing occurs. Such contextual organization provides a communal framework for members to pursue their interests and share their ideas in order to explore, debate, and advance both the individual and collective knowledge of a community. Various contexts motivate writers to compose for particular purposes and further determine what conventions are most commonly followed when writers select composing

content, adhere to a particular writing style, and follow certain format elements for "packaging" the content.

To examine this context-specific dynamic of writers and their writing from a rather basic and general perspective, discourse communities are loosely boundaried according to the common interests, shared ideas, and conventionalized language practices of participants within a given group. Within such communities, writers must come to know what issues concern the larger group if they wish to participate in mainstream discussions occurring within that context. Texts are thus shaped by the agendas of the larger community since writers want the ideas they express to appeal to those who share the same interests. The content considered important by the group is one force that shapes what writers produce, but content alone is not sufficient for attracting and holding the interests of that audience. In order to discuss relevant content issues, writers further need to acquire the special language used by other group members to articulate knowledge in a way that is familiar and specific to that group. Since communities both construct and are constructed by a specialized vocabulary that is unique to the group, it is necessary for members to participate in knowing and constructing that particular discourse.

In addition to collective knowledge and language practices, members within a specific community also share common writing conventions, such as style and format, to convey ideas. This collective agreement about conventions allows a community's members to communicate easily with one another since everyone shares the same expectations for reading and writing texts. Writing ability is thus further influenced by this need for writers to know the language, knowledge, writing conventions, and reading strategies specific to the community wherein they operate. To ensure effective

communication within particular contexts, both writers and readers must know the discourse and conventions specific to their discourse community.

Like the composing conventions followed in a discourse community, many writing situations also become conventionalized within a community since recurring rhetorical situations arise when the writing needs or purposes of participants similarly recur. Written responses to these repeated events then also become ritualized, causing genres to emerge within a community. In short, typified social writing purposes generate equally typical responses, or genres. In order for writers to learn the genres characteristic of a given community, they must learn more than textual features. The learning further requires knowledge of the socially created contexts and purposes that generate the need for various ritualized written reactions.

Since a community is largely determined by common knowledge, language, and communication conventions, novices must learn the community's ways when they join a particular collective. New members do this in several ways. They talk with others and read written texts in order to absorb the knowledge, vocabulary, and communication conventions of the group. At some point they also produce their own texts which are shaped and sanctioned by the shared expectations held by others in the community. Writers therefore learn to articulate suitable ideas using community-sanctioned discourse in appropriate forms and styles.

Universities in many ways create a context where people can become knowledgeable of the discourse and conventions of their chosen community. Professions like Law, Medicine, Engineering, and Education introduce members to their culture through specialized academic training programs, and it is often within this formalized and structured context that initiates begin to acquire the conceptual knowledge specific to that

community. In this way, university programs create an environment that allows newcomers to develop the specialized discourse used to articulate communal knowledge and concepts, and further enables them to learn the sanctioned conventions for reading and writing within that discourse community. Such institutions can convey much of the knowledge, discourse, conventions, and genres of the professional discourse community that students choose to enter. It is here that students learn many of the ideas that have currency within a group, the specialized discourse used to articulate those ideas, and the various forms and writing styles for communicating with others in the community.

THE PURPOSE OF THIS STUDY

Composition researchers and theorists rely on this notion of discourse community to examine how writers develop their composing ability in various contexts. If writers are to be successful, then, in a general sense, they must learn what knowledge a community considers important, the discourse members share to articulate communal ideas, what genres are relevant to the community, and what conventions are used to express group knowledge in the approved discourse. While there are many researchers who have examined the way in which writers learn to write within their professional discourse communities, there are fewer studies of university students acquiring the composing conventions of their discipline in preparation for their eventual workplace. In order to develop this research area more fully, the purpose of this study is to examine one learning context designed specifically to help students acquire the writing conventions of their profession.

RESEARCH CONTEXT

The students in this study are enrolled in the Technical Paper I and II Writing courses offered by Eastern University's Department of Chemical Engineering. This research site was selected because these writing courses represent a direct, overt attempt on the part of the university to prepare students for writing in the workplace. The approach followed for helping students learn this workplace writing is to teach a standardized format for writing a technical report - a document departmental administrators and course instructors identify as the most common report chemical engineers write in the workplace. All students are thus taught the same technical report format in an attempt to teach them how they will be expected to write for their professional industry. This approach is based on an assumption that students can adapt the format they learn for writing this technical report in school to relevant professional writing situations once they enter the workplace.

This research focuses on various aspects of the technical report teaching, learning, and evaluation process in order to examine how effective the courses are for preparing students to write in eventual professional contexts. Of particular interest is the way in which teachers characterize the technical report according to its textual features, and this emphasis subsequently becomes the basis for student learning. Such a focus on the teaching of a textual notion of genre in order to teach students how to write for the workplace is examined in light of current assumptions about the social nature of writing and its dependency on the knowledge, discourse, and conventions of a given community.

METHODOLOGY

Data collection methods for this study, like much of the research conducted to better understand writers in their social discourse contexts, are qualitative in approach. A qualitative research methodology is appropriate for studies of this nature since it better enables investigators to examine the social, interactive, and dynamic nature of writers in their composing environments. Data collected for this research are thus derived from a number and variety of transcribed interviews, classroom observations, and textual analyses of both student reports and course documentation.

The advantages of following this data collection approach are twofold. First, it allows for a comprehensive analysis of the research setting in order for many influences upon writers and their writing in their social context to be examined. Second, this study contributes to an ongoing and expanding discussion of what researchers and theorists know about writers in their composing contexts. Because qualitative studies are designed to consider many dimensions of writers in their contexts, then investigations of this nature tend to complement one another, add further insights into this overall research area, and allow for consensus building within the field.

In light of the purpose and theoretical framework of this study, the nature of the research site examined, and the issues raised in complementary investigations, the following five general questions, developed more fully in Chapter Three, are addressed in Chapters Four and Five: What background do students bring to the writing task that influences their writing decisions? What do they understand is the purpose of writing a technical report? How do the educational components of the course help students learn to

write a technical report? How is the issue of genre dealt with in both Technical Report writing courses? How might the Technical Report writing courses be improved?

The discussion that follows in Chapter Two examines the theory and research of novice writers learning to compose within the academic discourse community they have chosen to enter.

CHAPTER II - REVIEW OF RELEVANT THEORY AND RESEARCH

INTRODUCTION

This chapter establishes the theoretical and research framework for this investigation. In general, the issues developed throughout this section of the thesis explore the nature of knowledge, discourse, and communication as social constructs determined and boundaried by the discourse communities wherein writers are situated. These concepts are integral to current assumptions about writing and the development of writing ability, so the roles of readers, writers, and texts within these social contexts are examined. To begin this analysis of the social nature of writing, the following section first outlines how research in composition has evolved to situate writing as dependent on community (for a fuller discussion see Berlin, 1982, 1988; Bizzell, 1982; Faigley, 1986; North, 1987).

EVOLVING TO A SOCIAL PERSPECTIVE

This discussion begins with what is often described as textual (Faigley, 1986) or product-based research, since this area of study marks a major point in the development of composition as an independent investigative field. The primary focus of studies conducted in the 1960's and 1970's was to examine only finished texts, or the writing products of composers, to identify growth in writing ability. Such growth was determined through a quantified assessment of the increased complexities in structural elements such as sentence length, paragraphs, sentence structure, vocabulary, and so on (Hunt, 1965 & 1977; Christensen, 1967; O'Hare, 1973; Strong, 1973; Loban, 1976;

Christensen & Christensen, 1976; Stewart, 1978). It was, essentially, a period that emphasized skill development in the superficial structuring of written texts (Dixon, 1967).

Researchers recognized, however, that the singular focus on final product assessment offered a narrow view of writing. Writers themselves - those responsible for generating written texts - were not considered as in anyway integral to the overall development of writing ability. The focus was on what had been written, and looking for signs of development in texts, with little consideration given to the composers responsible for generating written documents. Researchers came to recognize that writers needed to be more prominently situated when examining composing development since writers themselves were responsible for generating written texts.

This then lead to an awareness by researchers and theorists that writers themselves had to be stimulated to write before development could actually occur in the writing itself. This change in thinking lead many in the field of composition to support an expressive (Faigley, 1986; Berlin, 1988) or "authentic voice" (Bizzell, 1982) approach to composition as advocated by proponents such as Donald Murray (1978) and Peter Elbow (1973). This theoretical perspective translated into an instructional practice where students were encouraged to invest more of themselves in their writing, to feel passionate about the ideas articulated in their texts, and to "find their own voice" by writing about issues they felt were most important.

This movement was criticized, however, because it was perceived as failing to promote a more critical way of thinking among students. Those adverse to this expressive approach maintained that developing writers failed to learn how to argue, question, or reason, and therefore grow intellectually (Bizzell, 1982, p. 194). Writers, critics argued, were able to express what they felt strongly about, yet were not challenged

to examine issues critically. This concern for the intellectual development of writers caused researchers and theorists to place greater emphasis on the thought processes of writers and the need to stimulate that thinking to promote composing capabilities.

The authentic voice movement therefore gave way to research dealing with writing as a cognitive process. This research focused on the intellectual processes of individual writers when shaping meaning in written form. The process movement has, in many respects, had the strongest contemporary impact on changing the direction of composition research, theory, and instruction (Hairston, 1982), and assumptions about writing development from this research emphasis provide many major theoretical underpinnings for current notions about the way writers learn. Some of the more significant assumptions about writing development gained from this research are outlined below.

WRITING AS A PROCESS

Those researchers who focused their studies on examining writing as a process (Berkenkotter, 1981; Emig, 1971; Flower and Hayes, 1980b, 1980c, 1981; Perl, 1979, 1983; Pianko, 1979; Sommers, 1980) have repeatedly demonstrated that the act of composing is a dynamic, interactive, complex, and entangled web of intellectual activity comprised of planning, writing, and revising operations. Each writer, either consciously or unconsciously, determines when and how to plan, write, and revise as a text develops. This conception of writing is markedly different from an earlier view that writing happened in a series of linear, discrete stages. Traditionally, it was supposed that all writers first planned what they wanted to say, wrote their ideas, then revised to refine ideas and the readability of the text. It was not only assumed that this was the natural

progression for developing a text; it was equally assumed that all writers, without exception, followed the same process.

Another key assumption from process research, due largely to the work of Linda Flower and John Hayes (1977, 1980a; Flower, 1985), is that writing is essentially a cognitive activity rather than simply innate ability. To perceive writing as a process means that writers can learn to "think" through writing problems; in effect, to perceive writing as a problem-solving activity. From this perspective, writing is viewed as an activity that most can master if shown proper strategies, or heuristics, for improving the quality of a written product (see, for example, Dias, Beer, Ledwell-Brown, Paré, and Pittenger, 1990). Such a perspective again contradicts the more traditional notion that writers are born, not made, and people with inborn writing talents are simply "lucky."

Finally, a third and significant assumption from the research on writing as a process is that composing is essentially a collaborative activity. Traditionally, researchers perceived that writers were self-reliant and autonomous, and therefore needed little help with their writing. Writing was perceived as an isolated, independent act to be carried out in private by a writer who "finds and expresses latent thought...by means of introspection" (Lefevre, 1987, p. 24). Currently, however, many researchers argue that writing is not an activity conducted alone, but is in fact an act of collaboration. This collaboration is generally perceived as occurring on two levels.

Defined more broadly, collaboration is considered from the perspective that ideas expressed in writing are not the sole property of a single author (see Bruffee, 1984). Knowledge is actually derived from an ongoing, and therefore evolutionary, collaboration between writers and ideas. What are often perceived as "new" ideas are in fact built upon existing knowledge (Cooper, 1986). In other words, new ideas evolve from

knowledge already decided, so writers are, in effect, contributing to conversations that are constantly ongoing and always in a state of evolving. From this perspective, writers are therefore working in collaboration with others to keep conversations moving forward.

On a more narrowly defined level of collaboration, writers also need to interact with other writers and readers while a text is in progress. Composers often benefit from talking with others before writing in order to explore ideas and gain added insights into what they are about to write. Talking with knowledgable readers while a text is in the process of being written is particularly helpful since it provides writers with valuable reader feedback throughout the composing process to aid with ongoing revision. Most researchers no longer perceive writers as functioning in isolated composing contexts where they retrieve innate knowledge and write for reaction from a wider public audience. These social perceptions about writing are explored more fully in the following section.

PROCESS VS. SOCIAL CONSIDERATIONS

Like earlier textual and expressive trends, elements of the writing process movement is also somewhat contentious for many composition researchers and theorists. Critics argue that when writers learn to think through problems and collaborate with others to shape written texts, these activities are dependent upon the setting or context wherein each writing activity occurs (see Berkenkotter, 1991). A key problem with cognitive process studies is that writers are often examined in artificial research settings rather than in natural, authentic writing environments. As writers compose in fabricated situations, researchers examine the problem-solving processes of these writers to learn

how they resolve composing conflicts. The processes examined, however, are often perceived as not reflecting authentic writing demands. In artificial research settings, writers and their texts are decontextualized - removed from a legitimate context where a real written response is required for a legitimate writing task. Writing activities driven purely by research are therefore viewed as artificial and fail to reflect more natural processes of writers in the "real" world (Brandt, 1986).

As well, although cognitive models of writing can describe how writers progress through a composing task, they do little to explain why writers make the decisions they do while writing since writing demands are not genuine. Writers are not responding to an authentic and personal need to compose. This is problematic for many researchers and theorists since the purpose for writing, the context wherein a writer is situated, and the writing conventions to be followed in specific writing environments are factors that direct a writer's decision-making process. In other words, even though writers set goals and use problem-solving strategies, they do so within a discourse community where conventions influence the goals that direct the writing process.

> We might say that if this model (Flower and Hayes') describes the form of the composing process, the process cannot go on without the content which is knowledge of the conventions of discourse communities. In practice, however, form and content cannot be separated in this way, since discourse conventions shape the goals that drive the writing process. (Bizzell, 1982, p. 231)

Artificial research settings fail to provide authentic contexts with legitimate writing purposes and conventions, so these studies do not accurately reflect a genuine composing process. Subjects write in response to a fabricated purpose, and decisions are not guided by the conventions of an authentic writing context. Research now indicates that social context strongly influences the way writers compose. Writing can no longer be perceived

strictly as a cognitive problem-solving process to which general or universal problem-solving strategies are applied. Such strategies need to be derived from specific writing contexts and similarly applied to the writing problems encountered within that same specific setting. Problem definitions, or writing purposes, and their resolutions are dependent upon social context and need to be examined from a social perspective (Carter, 1988).

It is this concern for the nature of and influences on writing in social contexts, or discourse communities, that has brought about what is most often referred to as the social constructionist view of writing. In brief, the underlying assumptions of this perspective hold that writing is not the singular outcome of a thinking process, but is in fact guided and directed by the norms, standards, and conventions established by the various communities within which writers operate. In other words, how a person writes is not only defined by decisions made about a particular text's audience and purpose, for example, but is also, and necessarily, determined by the language, style, form, and subject matter relevant to a discourse community. These concepts are developed more fully in the next section.

THE DISCOURSE COMMUNITY CONCEPT IN COMPOSITION STUDIES

INTRODUCTION

This section of Chapter Two outlines the theoretical underpinnings of the "discourse community" concept as it applies to the field of composition and further provides an account of key research studies relevant to this theory. The principles constituting this concept provide the theoretical framework for the social constructionist view of writing as well as this investigation since both are based on the fundamental perception that writing is a socially directed activity. Positioning the concept within such a framework is necessary since, as Joseph Harris observes, establishing the parameters of a discourse community is a rather arduous task:

> recent theories have tended to invoke the idea of community in ways at once sweeping and vague: positing discursive utopias that direct and determine the writings of their members, yet failing to state the operating rules or boundaries of these communities. (1989, p. 12)

And Hertzberg (1986), in keeping with Harris, claims that while the whole notion of a discourse community signifies a "cluster" of ideas, there is no single definition for the concept. In other words, the discourse community notion is multifaceted to the extent that the concept does not lend itself to only one explanation. Bazerman (1987), like Harris and Hertzberg, similarly notes that the term has "great intuitive force," but, "we can define no stable thing such as a crisp discourse community, even though we may maintain a general statistical impression that such things exist" (pp. 5-6). As these theorists observe, the discourse community concept lacks stable definition and stated boundaries or rules, and is also vague in definition. The term has, however, become extremely important to current assumptions about composition.

In examining how the concept has evolved to become so central to writing research and theory, it is evident that the field of composition is truly interdisciplinary since researchers draw from several academic areas to articulate the discourse community concept. In many respects, composition may be described as a hybrid field since it relies on tenets from multiple disciplines including rhetorical studies, literary theory, linguistics, cognitive studies, sociology, and writing pedagogy. The following examines some of the major interdisciplinary theoretical underpinnings constituting the field of composition's notion of a discourse community.

THE SOCIAL NATURE OF KNOWLEDGE

In essence, proponents of the discourse community approach to writing and its development are social constructionists who embrace the notion that human realities are socially, and therefore subjectively, constituted. This perspective stems from the field of Sociology and the work of sociologists like Berger and Luckmann (1967) who argue that societies in general are socially constructed phenomena. These societies can be determined on any of a number of levels from macro groups such as races or tribes, to smaller social units like cities, clubs, families, and so on.

Regardless of size or type, groups are identified ***as groups*** because members have certain characteristics in common which enable them to be identified as part of a particular organization. Language is one of the more obvious features of commonality among a group of people. Members also share a common knowledge. They share common ideas, ways of thinking, and ways of perceiving that are considered customary among participants within a given group. Such commonality means that people

constituting a particular group possess a common lens through which to view their world order and shape their reality. It is this shared framework of beliefs, thoughts, ideas - in essence, knowledge - that constructs a common lens for perceiving reality.

Knowledge common to a particular group serves to unify its members and is, like the group itself, socially constructed: "ideation, subtle or otherwise, is a cultural artifact" (Geertz, 1983, p. 152). Knowledge is not a set of abstract, objective, universal truths imposed on individual groups; it is, like organizations themselves, socially constituted; determined and upheld by group members. As Geertz explains, knowledge "is not a matter of matching varieties of consciousness to types of social organization. It is a matter of conceiving of cognition, emotion, motivation, perception, imagination, memory...whatever, as themselves, and directly, social affairs" (Geertz, 1983, p. 153).

Knowledge cannot, therefore, be separated or examined objectively and in isolation from its social context. Nor can it be separated from individuals themselves since it provides the lens through which people evaluate, and subsequently accept or reject, ongoing encounters with new ideas. In order to make such assessments, an individual's knowledge is often internalized to the extent that no separation exists between a person and his or her ideas. Members not only come to occupy some sort of role within a community, but actually adopt a way of being within the world or acquire a cultural frame defined by the group. It is the customary features, habits and functions that members of a group must become familiar with in order to be recognized as a member of that community and to function as a full participant. There are so many ideas and language uses with which a new member must become conversant, and the ways of a community are so numerous that, in their learning, members are likely to become and to live what they practice rather than simply fulfil obligatory roles and duties.

In his analysis of the various academic disciplines as socially constituted communities, Geertz (1983) explains that

> the various disciplines...that make up the scattered discourse of modern scholarship are more than just intellectual coigns of vantage but are ways of being in the world...[it] is not just to take up a technical task but to take on a cultural frame that defines a great part of one's life....Those roles we think to occupy turn out to be minds we find ourselves to have. (p. 155)

Over time, as people are immersed in, and become socialized to, a community's ways, they are transformed from mere observers outside of the group to active participants contributing to the community. Dorothy Winsor (1990) argues this same position based on her study of an engineer during his process of writing a technical report. One focus of her study is the extent to which a community's texts shape the knowledge and behaviours of participants to help them take on the form and likeness of the community. Winsor echoes Geertz's contention by suggesting that the writing tasks of engineers are not only a key means of producing knowledge within a community, but are also the way in which engineers write or create themselves:

> For an engineer to be accepted as an engineer, he or she must write and speak in the already-created forms and tongues of engineering. Thus, while it is possible to say that engineers create themselves in texts, it is also possible to say that they are created by the texts available to them. (Winsor, 1990, p.67)

In other words, Winsor argues, engineers must follow the forms and writing procedures expected by their discipline, and, in so doing, establish themselves as engineers within their community through the texts they write. At the same time that engineers are asserting themselves in writing *as* members of their community, however, they are also being shaped by the texts that they read and model. This is particularly evident given the fact that the engineer's technical report contained a recommendation section even though these recommendations had been previously tested and acted upon.

Even though the outcome of each recommendation was already known, the section had to be included in the report because, the engineer stated, it is "customary" within the field to do so. This writer is therefore shaped by his community to think as a member of his profession and to satisfy the conventions expected by that community.

Winsor's study (1990) further demonstrates the way in which knowledge is socially constructed and mediated through texts within discourse communities. Raw lab data is used by the engineer as the basis for interpretation which, when analyzed, is recorded in written form to then represent the knowledge of that community. Since the data alone cannot speak for itself, "knowledge is thus constructed through texts, not discovered in the original process of lab work" (p.60).

Engineers, as with writers in other communities, do not rely solely on data from a lab or other such non-textual forms of information. The ideas and interpretations given to that information are informed by an accumulated and ongoing encounter with material contained in other texts, both oral and written, as well. The technical report in Winsor's study, for example, was not only written based on data produced in a lab, but from business meeting handouts and oral presentations as well. These other texts proved to be of such value, in fact, that the key person responsible for their production and delivering the oral presentations was established as co-author of the engineering report.

Paré's study (1991, 1992a, 1992b) of social workers writing Predisposition Reports (PDR) in the Quebec juvenile court system further reflects the way in which textual production is the result of many voices and influences. The PDR, as Paré explains, "is a social worker's advisory report to a judge on the sentencing (disposition) of a minor found guilty of an offence under the Criminal Code" (1992b, p. 51). Report content comes from multiple sources including the young offender and her or his family,

the police, and, if there is one, the victim. This information is collected through interviews conducted in person and over the phone as well as from other written documents for the case. As Paré notes, "the PDR is an example of Bakhtin's 'heteroglossia': the text is full of the words of others; it grows out of and enters back into an intricate network of voices, roles, and relationships" (1992b, p.52).

It is not only members of the sociology discipline who argue in favour of a socially constituted view of knowledge dependent upon social context; and nor does the field of composition depend solely on this field for its understanding of the discourse community concept. Assumptions about the social nature of knowledge are also grounded in the sociology of science, due largely to Kuhn's discourse on the philosophy of scientific knowledge as a social construct. Essentially, in The Structure of Scientific Revolutions (1970), Kuhn argues that scientific thinking changes in a revolutionary rather than an evolutionary way. In other words, the growth of scientific thought does not evolve in a non-disruptive, incremental manner where new insights are added to existing precepts. Instead, knowledge is revolutionized as old paradigms of thought, perceptions, or world views are exchanged with newer models or ways of seeing.

Rorty (1979) generalizes and updates Kuhn's position to argue that all knowledge, not just the scientific, is a social construct. This perspective contradicts traditional foundational views advocating that universal knowledge and truths provide the foundation upon which new ideas are founded. For social constructionists, their antifoundational views hold that universal knowledge structures do not exist: "there is only an agreement, a consensus arrived at for the time being by communities of knowledgeable peers" (Bruffee, 1986, p. 777).

THE SOCIAL NATURE OF SPEAKING AND WRITING TEXTS

The avenue through which knowledge is generated and shared among the members of a community is, of course, based on common language practices. This section therefore examines the nature and role of language within groups since it not only extends this discussion about the nature of knowledge and groups as social constructs, but is also integral to the discourse community concept within a composition theory and research framework.

Perceptions of language as a socially derived phenomenon stem largely from Vygotsky's (1962 & 1978) studies of the relationship between thought and language in child development. Vygotsky maintains that children begin their oral language experiences as a form of egocentric speech (1962, pp. 14-18) in which they talk aloud about the things they do. This personalized speech then grows in two directions as the child matures: outward, away from the self, through conversation in specific social contexts; and inward to become inner speech. Speech activities become internalized verbal thought so language is, at times, more of a mental, as opposed to an oral, operation. As children mature and develop, they become more adept at alternating between inner and rule-governed outer speech according to their language needs.

Central to Vygotsky's theory of the reciprocal relationship between thought and language is the contention that language itself is determined by an historical-cultural process (p. 51). The form and function of thought and language are not innate, but learned through social/cultural observation and interaction. In short, language rules are learned by observing their effects within the contexts and social situations that language is used.

Most sociolinguists identify these individual contexts wherein language is used and governed by contextual rules as speech communities. The speech community concept relates to the discourse community concept within composition in that it deals with the shared oral conventions of members within a discourse community. Language is socially defined, primarily by oral similarities like terminology and usage, and shared by members within a group. These common language practices among members serve to maintain a group's social identity (see Grumperz, 1971).

Sociolinguist Gunther Kress insists, however, that linguists cannot identify speech communities (or speech events) unless language is securely positioned within a social context:

> An explanation for differing modes and forms of speaking can only be given when we look at the phenomenon from a linguistic **and** social perspective. Then we find that these speakers share membership in a particular social institution, with its practices, its values, its meanings, its demands, prohibitions, and permissions. We also begin to get an explanation for the **kind** of language that is being used, that is the kinds of texts that have currency and prominence in that community, and the forms, contents and functions of those texts. (1985, p. 6)

Kress' notion of "text," as used in the above context, is not restricted merely to printed documents. He argues that, since language does not operate in isolation - as mere words and sentences - but is entrenched and understood from the socially contextualized purpose wherein that language is used, then "language always happens as text" (p. 18). This notion echoes Bakhtin's concept of the "'implied' text: if the word 'text' is understood in the broad sense - as any coherent complex of signs" (1986, p. 103).

Bakhtin (1986) argues, like Kress, that linguistic utterances are entrenched in and determined "by the specific nature of the particular sphere of communication," and "reflect the specific conditions and goals of each such area" (p.60). According to Bakhtin, speech genres emerge when utterances within socially determined spheres

become relatively stable in terms of type and usage. Language development therefore occurs through engagements with these "texts" and "genres" in various social contexts. "Writers have the words - and more importantly, the systematic organisation of words - given to them by the discourses and genres of which they have had experience" (Kress, 1985, p. 48).

French philosopher Michel Foucault describes the context-dependent use of language as systems or "discursive formations." These formations are, essentially, the language systems, or discourse, of socially defined groups and institutions which are constructed to convey meaning and values:

> Exchange and communication are positive forces at play within complex but restrictive systems; it is probable that they cannot operate independently of these. The most superficial and obvious of these restrictive systems is constituted by what we collectively refer to as ritual; ritual defines the qualifications required of the speaker (of who in dialogue, interrogation or recitation, should occupy which position and formulate which type of utterance); it lays down gestures to be made, behaviour, circumstances and the whole range of signs that must accompany discourse; finally, it lays down the supposed, or imposed significance of the words used, their effect upon those to whom they are addressed, the limitations of their constraining validity. (1972, p. 225)

Kress (1985) shares Foucault's assertion that modes of

> talking or discourses are systematically-organised sets of statements which give expression to the meanings and values of an institution....A discourse provides a set of possible statements about a given area, and organises and gives structure to the manner in which a particular topic, object, process is to be talked about. (p. 7)

Thus, when composition researchers and theorists speak of a discourse community, the concept is embedded in the understanding that knowledge, thought, and language are socially constructed and originate within a particular community (see Bruffee, 1986). There is, then, an antifoundational, social constructionist view of

society, groups, communities, knowledge, discourse, texts, and genres that serves as the lens through which assumptions about discourse communities in composition are constructed.

There is a need, however, to develop the concept still further since discourse communities include written as well as spoken communication. Sociologist Howard Becker addresses the social nature of writing in Writing For Social Scientists (1986). He reflects upon this process as both a sociologist and university teacher. As a sociologist he is aware of the social nature of learning through group interaction and argues that "the way people write grows out of the social situations they write in. So we need to see...how social organization creates the classic problems of scholarly writing" (p. xi).

As a teacher, he is familiar with the problems both initiates and established writers within sociology encounter, and contends that "problems of style and diction invariably involve matters of substance" (p. xi). In other words, textual style and format cannot be learned or treated separately from content or context. In fact, for Becker, these two dimensions are so inextricably entwined, he claims that "if writing about society will improve only when sociologists study grammar and syntax seriously, it never will" (p. xi). He thus situates the conventions - or problems and peculiarities - of scholarly writing specifically within the academic context of Sociology (see also Brodkey, 1987).

Socializing writers to compose in specific ways in academic contexts occurs with even the youngest of children. In the research by Haas (1984) in which she studied kindergarten children learning to write, Haas determined that these students not only learned how to pen the cursive formations of writing, but they also learned how to perform various writing tasks required by school. In other words, the process of Kindergarten children learning letter and word formations does not occur in isolation,

even though this may appear to be the case, but is entrenched in the learning of how to complete school-based writing activities. Learning how to structure letters in print is a required school-based activity. Haas' research indicates that, even at this age and level of writing ability, learning proper language conventions is context-dependent since students are being socialized to the discourse community of school.

While children learn a more general form of academic discourse in school through the common writing tasks required, discourse and writing conventions become more specialized within specific disciplines at the university level (Herrington, 1985; Freedman, 1987; McCarthy, 1987; Berkenkotter, Huckin, & Ackerman, 1988). Universities typically help novice members become familiar with the complexities of their professional discourse. Such institutionalized programs provide a major pathway for learners into the ongoing conversation that surrounds them in their chosen professional contexts. In many respects, such institutions are the entry point for people outside of various communities to gain admittance. Universities convey the ideas that are important to a discipline by immersing students in the discourse, writing conventions, and reading strategies that have become stabilized within that community.

Academic communities exemplify the way in which language is governed by group conventions. Students who join an academic group must acquire the language used by that group to express their ideas both orally and in writing. They must, therefore, combine existing language practices with those expected by a newer and more specific discipline. Existing language uses are often seen as polarized against the academic discourse of a community a student has chosen to enter. In other words, the languages are perceived as somehow distinct, separate, and discrete from one another. The assumption is that students can and must be relocated from one discourse to the relevant

academic discourse in order to satisfy academic conventions (Harris, 1989). If, however, these differing discourses are perceived as overlapping rather than competing, then it becomes an issue of augmenting rather than repositioning a writer's discourse:

> Rather than framing our work in terms of helping students move from one community of discourse into another, then, it might prove more useful (and accurate) to view our task as adding to or complicating their uses of language. (Harris, 1989, p. 17)

But even by perceiving the task as augmenting rather than replacing students' language, a tension still exists between a primary (Bartholomae, 1985) or native (Bizzell, 1982) discourse and the discourse of a given discipline. Students must still adjust their own language to accommodate the language prescribed by their academic community. In order to become successful writers within their discipline, students must reach "some compromise between idiosyncrasy, a personal history, on the one hand, and the requirements of convention, the history of a discipline, on the other" (Bartholomae, 1985, p. 135).

Students must then augment their discourse competencies by learning the language and means of communicating specific to the discipline they have chosen to enter. The study of Nate (Berkenkotter, Huckin, & Ackerman, 1988) during his first year as a Ph.D. student reflects the way learners must acquire the advanced academic literacy required of a discipline. Nate experienced difficulty with moving from his familiar but informal writing style to a more formal, scholarly writing style which he was expected to use along with articulating the more abstract concepts of his community. With practice, however, Nate did become better able to discuss the issues that others in the faculty were concerned about rather than focusing so much on his personal beliefs in his discussions. This refocusing of his ideas meant that Nate was better able to contribute to the ongoing

conversation among scholars in that academic community. At the end of his first year, however, Nate continued to experience some problems with thematic continuity and overall textual cohesiveness since he was still "juggling [and therefore still learning] too many conceptual and linguistic constraints" (p. 36).

Bizzell (1986) maintains that "mastery of academic discourse must begin with socialization to the community's ways, in the same way that one enters any cultural group. One must first 'go native'" (p. 53; see also Reither, 1985). A key way of "going native" is, of course, through learning the language conventions themselves so new members eventually read, write, speak, and think like those of the majority within a given field. Thus, students must learn to speak with authority by using the voice and code of those with "power and wisdom" (Bartholomae, 1985, p. 156).

Bartholomae (1985) maintains that trying to enter an academic discourse community forces students to "invent" the university: "The student has to learn to speak our language, to speak as we do, to try on the peculiar ways of knowing, selecting, evaluating, reporting, concluding, and arguing that define the discourse of our community" (p. 134). Those who ultimately learn prescribed discourse conventions become active members within their academic community while those who do not are unable to become "privileged" members of the academy (see Bizzell, 1982; Bartholomae, 1985; Cooper, 1989; Harris, 1989).

Students learn the linguistic constraints of their profession through the social context that surrounds their learning. Though students are immersed and participate in a broad academic context through their association with a university culture, it is primarily in the classroom that students learn what discourse, ideas, and communicative conventions are required by the various disciplines. Learners may talk with peers and

speak informally with instructors about their studies, but it is predominantly the classroom environment where students learn the discourse, language strategies, and knowledge of their community.

Freedman's investigation (1987) of students just beginning to learn the discourse and ideas of the legal profession in an Introductory Law course exemplifies the way students draw upon their classroom social context to acquire the conventions of their community. What's more, the influences that Freedman identified within the learners' environment are dependent upon using the community's discourse in a variety of ways. Through reading, students not only began to learn what ideas were central to Law, but were also the look and sound of the discourse in written form. They further used these textbooks, in addition to their professors and teaching assistants, as models for speaking in the argumentative style characteristic of Law. Students practised articulating ideas in required conventions through group discussions, and their writing was informed by previous academic essay writing experiences, of which Law represented a variant, as well as writing within the context of the Law course (p. 104).

It was thus the socially created context of the classroom that enabled students to learn the writing conventions of their discipline. Freedman's study further indicates that it is through the involvement with coherent and structured spoken and written texts that new members learn both the knowledge and the specialized discourse of their community. Students were thus initiated into the "discourse community of students of Law: they had learned to share the conventions of language use, to approach problems and define issues in the manner of those already socialized into the discipline" (p. 99).

Though immersion in the social context of a discipline is central to learning a group's discourse and conventions; the type of classroom context created further

influences learning in a number of ways. Writing purposes, for example, as well as course objectives and the instructional approaches used to promote writing ability all impact how and what writers learn. Herrington's study (1985) investigating the contexts for writing in two college chemical engineering courses indicates how differing social environments impact upon the intellectual activities, social roles, and writing purposes created in each classroom.

Of the two courses studied, the Chemical Engineering Laboratory course required students to work in small groups where they conducted six lab experiments for six different professors and then recorded their interpretations and findings in a lab report. Conversely, the Chemical Process Design course required students to work in small groups and solve two design problems. Throughout each of these two projects, students wrote weekly progress memos and a final formal report. The course was team-taught by two professors and met twice a week, once for a full class lecture, and once for groups to meet individually with one of the professors.

Each classroom represented a different context since learners addressed different issues, assumed different roles as readers and writers, and the writing served different social purposes. As Herrington explains, the Lab course asked students to interpret or address the "what is" of their experiments for the professors. A student-teacher relationship was maintained throughout the course since students were expected to demonstrate mastery of their discipline's theoretical knowledge. Students therefore viewed the classroom *as* a classroom where they had to demonstrate an ability to do the experiments right for each of the six course instructors. In the Design course, however, students were asked to judge "what should be" for designing a process and making a recommendation to company management, so the course was perceived as a hypothetical

professional forum where students concentrated on developing a suitable design process for a supposed manager. The social relationship created in this context was one of employee-boss rather than student-teacher.

Student perceptions of the purpose and readers for both documents contributed significantly to the socially created learning environment of the classroom. In terms of the Lab course, students not only wrote to demonstrate their knowledge, but they also wrote to a teacher-as-reader who possessed a detailed knowledge of the discipline's theory and technical terms. Even though students were instructed to imagine they were writing for a boss, they still saw the teacher as their primary reader and wrote with this audience in mind. What's more, because the teacher/reader relationship changed for each experiment because of the new instructor for each experiment, students were consistently unsure about the amount of information and detail to include because of a superficial familiarity with each reader.

Since the Design course was structured as a hypothetical work situation in which students wrote weekly memos updating their progress and a final formal report for the project's design chief, students consistently wrote for the same reader. They therefore quickly learned the amount of detail required in their memos and report. As well, since students consistently saw their role as one of informing their reader, they became preoccupied with writing for a boss as a primary reader, in addition to the teacher, and were concerned with developing a suitable design process so the project would be accepted in the workplace.

The differences in the contexts created in each classroom clearly impact upon what students learn in terms of acquiring the conventions of their discourse community. In one instance, the Lab course, the purpose for writing was simply to demonstrate

mastery of specific knowledge to the teacher. Since the instructor changed for each experiment, the course seemed fragmented and a sense of community was unable to develop because students faced various uncertainties with each of their six teacher/readers. Conversely, Design closely modelled an authentic workplace and writing situation so composing was more purposeful for students. Writers were not simply concerned with regurgitating information for a professor, but became involved with the intellectual problem-solving activity of their profession and attempted to communicate that knowledge to readers in a convincing manner.

The above studies not only deal with the significance of the relationship between readers and writers and the expectations each holds for the other in writing, but they also address how the purpose or social function of various writing tasks similarly influences a text's development. In the Lab course, students had to demonstrate mastery of subject material in their writing which meant simply recalling theoretical information that teachers were already highly familiar with. Conversely, in Design, students had to manipulate information in a way that both informed and convinced readers that they possessed a solid understanding of the issues and concepts relevant to the discipline.

The significance of the social function for writing as it impacts upon writing ability is further emphasized in McCarthys' study (1987) of Dave, a biology/pre-med college freshman, whom she observed during his studies in Freshman Composition, Introduction to Poetry, and Cell Biology, each in a different semester, over a 21 month period. Each of Dave's three professors agreed that the purpose for having students write class papers was not just so they could demonstrate knowledge of specific information, but to develop and show their ability to use the thinking and language of their discipline. The purpose for writing summary papers in Cell Biology was to help

students become comfortable with speaking the language of that discourse community. The Composition course was similarly designed to get students comfortable with the writing conventions common in academic discourse, and Poetry was designed to teach how people in literary studies think and write.

While Dave successfully learned to write in Biology and Composition, he was unable to acquire the conventions for writing about poetry. McCarthy suggests the social function Dave's writing served in Poetry differed significantly from his other classes to the extent that he was unable to meet with success in Poetry. In both Composition and Biology, writing proved to be a meaningful, social activity since Dave, and his professors, saw such writing as useful and necessary for helping him in his future professional and academic pursuits. Conversely, Dave saw the only function for writing Poetry as one of showing academic competence. He did not see how such writing would serve him in any general way in his life, and there was not, therefore, any personally meaningful purpose to the writing.

In observing Dave through each of these writing contexts, McCarthy identified other factors in the social context created for learning which also significantly influenced his writing development. The relationship between Dave and each of his professors caused further differences in writing ability since the writer-reader relationships established for learning appropriate conventions also differed. Even though all papers were written for the teacher-as-examiner, Dave's composition teacher established herself as a writer and talked about her writing process. Dave therefore felt that he, together with his instructor, grappled with writing issues and collaborated to solve various writing problems. In Biology, both Dave and his teacher saw Dave as a newcomer to the class where the teacher acted as experienced professional, knowing and showing Dave how

things are done in the community for which, both assumed, Dave would eventually learn appropriate language use.

In both cases, Dave not only interacted with his instructors, but participated in group discussions with peers as well. Student interaction therefore played a major role in Dave's writing success in Biology and Composition. In Biology, although time was not given for students to share their texts, they talked informally outside class and the professor occasionally participated in their discussions during lab sessions. In composition, students frequently shared their texts in group sessions and the professor used both her own and student writing models to deal with writing concerns.

In Poetry, however, the rapport between Dave and his professor was such that he consistently felt like an outsider against the insider teacher who knew poetry. Part of the reason for this stems from his inability to interact with either the professor or other students during class. Students were not invited to share their ideas, either about poetry or writing about poetry, since the class adhered to a lecture format. Moreover, any text models presented in class were those written by the professor, so students were unable to see how peers dealt with particular writing problems.

The research indicates that the type of social context created for learning directly influences a writer's ability to learn the discourse conventions of a discipline. The above studies demonstrate that when writing has a purpose other than simply showing mastery of a specific area of knowledge, and that when the writing has some goal other than writing for a teacher, then activities become more meaningful to learners. Clearly, language learning is a primary means through which students move from outside of their chosen discipline to become inside members of that academic community. Students must therefore reconcile their own sociohistorical linguistic development with the language of

their academy in order to think, know, communicate, value, and share the same interests as those already entrenched within a particular community.

Teacher feedback to the written texts students produce also plays an important role in learning the knowledge, discourse, and conventions of a discipline. As Freedman (1987) notes of the students in Introductory Law, these writers did not consciously articulate the necessity for them to learn a new language and writing style in order to operate effectively within the legal profession. They did, however, approach their writing with a "dimly felt sense" or general impression of the discourse and conventions expected by the legal community. This dim impression of what legal discourse should look and sound like was not only refined during the course through their many encounters with oral and written texts, but also through feedback received from both their instructor and teaching assistants.

According to Currie (1992), the more sophisticated a reader's knowledge of a community's conventions, the more detailed the response for showing writers how to make their writing conform to reader expectations. In looking at the role of argument in Organizational Behaviour, where students must learn to resolve issues in writing, Currie examined the differences in response and evaluation between the course's teaching assistant and program coordinator.

The assessment results of two assignments for each of the three student writers studied showed a significant difference in that the assistant's marks consistently averaged two or three points higher than those of the coordinator. Currie's analysis of evaluative responses indicates that the assistant did not share the same enculturated conventions for argument in form or context as the coordinator. "In short, she did not share their genre of argumentation" (p. 8). Such a discrepancy meant that the students did not acquire the

appropriate conventions as well as they might have since the teaching assistant was similarly restricted in knowing required conventions.

Schwegler and Shamoon (1991), in their study examining the conventions Sociology professors rely upon to read the essays of their undergraduate writers, further reflect on how professors within academic communities have a strongly internalized sense of the writing conventions required for their discipline. These researchers determined that texts deemed acceptable were written by students who adhered to the assumptions and constraints of the discipline as internalized by the instructors. Not surprisingly, socially driven schema prompted the professors to provide certain types of feedback which enabled students to acquire both knowledge and a greater ability to write as members of the academic community of Sociology.

Writing, like speech, is learned as writers participate in either an academic or other such community where specific writing conventions are used. The discourse community notion is therefore employed by theorists and researchers in composition because it accommodates "some of the special circumstances of written language" (Faigley 1985, p. 238). Some of these special circumstances include the need for members to correspond without being impeded by factors such as time and distance. Writing ensures that ideas are sustained and can be returned to over time. It also maintains the integrity of what is spoken over any distance since words are recorded in written form. Communication is thus unrestricted among members within a community (Swales, 1988, pp. 211-212).

THE SOCIAL NATURE OF READING TEXTS

Not only must texts be written according to the conventions deemed appropriate by various communities, but they must be read and understood by members within a group as well. Composition experts therefore rely on literary criticism's notion of the "interpretive community" (Fish, 1980) to demonstrate the reciprocal relationship between the reading and writing of texts by members within the same specific community. Fish's notion of interpretation relies on the interaction between a reader and text to generate meaning from print. This means that textual understanding does not reside solely in the words recorded on paper since such understanding requires a reader to engage with the literature to create meaning. How readers actually read a text, however, is influenced by the way they have learned to read. In other words, readers, like writers, are situated within language-using contexts, and these contexts inform the interpretive decisions of readers.

Current notions of textual response and interpretation stem largely from the field of literary criticism where critics such as I. A. Richards (1929), F. R. Leavis (1962), and Louise Rosenblatt (1978) have long argued for a more comprehensive, even redirected, understanding of textual interpretation. Theorists such as these contest the more traditional and widely held view that the locus of meaning for any text rests solely in the words recorded on paper. Through their work they have challenged the idea that a text represents some code that a reader must break, and break correctly, before the one true and prescribed interpretation can be extracted. These critics, in effect, dispute the narrow perception that a text holds only one meaning that all readers should share when they encounter the same text.

Rather than perceiving reading as unidirectional, from text to reader, critics like Rosenblatt argue that reading is really a dynamic, intertextual, historical, and even personal endeavour. Because readers bring their individual and multifaceted histories, which no two readers ever share, to their reading, these experiences inform the interpretation taken from each textual encounter by each reader. Personal knowledge and experience, be that "historical, philosophical, psychological, political, for example - may yield special angles of vision or powerful organizing frameworks" which causes each reader to evoke an equally individual response to a text (Rosenblatt, 1978, p.147; see also Richards, 1929). As Leavis says in discussing the nature of responding to poetry, you "cannot point to the poem, it is 'there' only in the recreative response of the individual to the black marks on the page (1962, p.28; see also Cooper, 1985; Dias, 1987; Dias & Hayhoe, 1988).

Common dimensions of interpretation do occur, however, in spite of the individuality of readers and writers. Although they have their unique ways of seeing and perceiving, interpretation is constrained by the commonly held language, beliefs, and interpretive strategies of members within a discourse community. A text, in effect, acts as a blueprint. Readers complete or fill out the meaning derived from a text when they engage with the writing. Readers do, however, share common assumptions about textual meaning because they are positioned within a discourse community that has informed their way of thinking and perceiving, so group members do share common ways of interpreting and understanding the texts of their community.

Just as a discourse community influences the way writers craft their texts, writers, who are also readers within their communities know how to read by learning the interpretive strategies used by members of the collective. Over time, readers become

familiar with the community's discourse, recognize how arguments are formulated and presented, and realize which ideas have currency within the group. Once these strategies have been learned, readers then share a common approach to textual interpretation.

Such commonality in reading schema is not to suggest that all readers are alike, however. A tension still exists between the individuality of readers' responses and the sameness of shared textual interpretation. It is this tension between similarities and differences that often generates discussion and debate within a group, the dialogue of which typically serves to advance ideas within a community. Readers are guided by how to read based on the knowledge they have acquired through life, language, and reading experiences. This collective experience forms the schema for the texts with which readers engage since it provides the foundation for understanding ideas encountered while reading. Within discourse communities, readers develop a schemata for reading texts where they not only expect to see a particular discourse used, but they also expect certain forms, tones, and structures to be followed according to the conventions set by the community. To write effectively, writers need to know what these many conventions are in order to satisfy reader expectations.

Many composition researchers are particularly interested in studying the way readers react to texts within discourse communities since writing ability is strongly influenced by writers' knowledge of their readers. Reading and writing effectively work as interrelated and reciprocal activities. A study by Myers (1985), in which he examined the writing processes of two biologists writing grant applications for research funding is particularly telling of the way writers must learn how to accommodate reader expectations, and therefore writing constraints, while composing. Both of the writers Myers investigated were repeatedly required to revise their proposals to make their

documents fit better the writing expectations for proposal writing within the scientific community.

Myers indicates that these writers operated under both implicit and explicit regulatory constraints while writing their texts since, on the one hand, both writers had to follow documented guidelines for completing their applications. On the other hand, they also had to be covertly persuasive in order to convince readers of the value of their research. Such persuasiveness depended in part on each writer's ability to develop the persona of an established member within the scientific community. The way for these writers to show they were part of the establishment was to situate their proposed research within an existing body of literature. The delicate balance that had to be struck in this instance was one of demonstrating the community's knowledge, yet proved that the research would advance that knowledge for the community.

While striving to meet with the above criteria in their proposal writing, the writers also had to make their texts readable to both members and some non-members of the scientific discipline so all of those required to review the proposal could understand each writer's arguments. Code words and field jargon had to be clarified, so semantics, in addition to tone and content, required careful attention during the application writing process. In general, the proposed research projects changed considerably with each revision in order for the texts to comply with many imposed writing constraints and to meet reader expectations.

The social workers Paré studied (1991,1992a, 1992b) as they wrote predisposition reports for the Quebec juvenile court system were similarly constrained by their readers. While the primary reader for the predisposition report was the judge, this one person was not the only reader since the adolescent, his or her family, lawyers, court clerks, and

even possibly psychologists and psychiatrists also read the report (1992, p. 52). The social workers therefore needed to make their reports readable by people both in and out of the legal system, and were therefore constrained by the need to write for many readers. For example, they had to explain technical or context-specific terminology for readers unfamiliar with the justice system. Information similarly needed to be worded in a way that did not insult either the offenders or their families since social workers typically ended up working with an adolescent over the long term so a positive rapport had to be maintained.

THE ROLE OF GENRE IN DISCOURSE COMMUNITIES

From the above discussion, it is evident that the way texts are both written and read are important factors in understanding discourse communities since it is through texts that a community's language is represented. Texts are typically written by writers, as members of various communities, who compose with an audience of peers in mind. Since writers essentially write to their contemporaries, then they expect and assume that members of their community will read the texts they produce (Freedman, 1989).

In part, then, textual meaning is carried by and through this reader/writer transaction based on a shared knowledge and a shared discourse. There is, however, another dimension equally important to ensuring such reader/writer transactions occur. Since discourse communities are socially constituted, the social occasions wherein texts are used significantly impact upon the texts themselves. The form and function of the social context, as well as the purposes of the participants, determine the form, function, purpose, and meaning of a given text (Kress, 1985). Thus, when the form and function

of social occasions become conventionalized, as well as the writing purpose of the participants, texts also become conventionalized, resulting in specific genres: "genres have specific forms and meanings, deriving from and encoding the functions, purposes and meanings of the social occasions" (Kress, 1985, p. 19).

This notion of genre, wherein the socially determined rhetorical situation is considered along with typified textual constructs, broadens and therefore changes conventional views of genre (see Ongstad, 1992, for a detailed discussion of the development of various viewpoints on genre in several disciplines). Traditionally, genre was largely associated with formal textual features, particularly characteristics defining literary texts: "A literary genre is a recognizable and established category of written work employing such common conventions as will prevent readers or audiences from mistaking it for another kind" (Baldick, 1990, p. 90).

From this definition it is evident that genre was identified by its regularized form and textual features in order to "prevent readers or audiences from mistaking it for another kind." Bakhtin similarly notes the customary focus on examining genre from a literary and textual perspective rather than situating texts as reflections of common ways of speaking (or uttering) in various typified social situations.

> Literary genres have been studied more than anything else. But...they have been studied in terms of their specific literary and artistic features, in terms of the differences that distinguish one from the other (within the realm of literature), and not as specific types of utterances distinct from other types, but sharing with them a common verbal (language) nature. (1986, p. 61)

Bakhtin subsequently argues for a more broadly defined notion of genre as a repeated social action that generates a typified or symbolic textual form in response to that action. When social occasions become conventionalized, texts reflecting the needs

and purposes of the group are similarly ritualized in response to the repeated social situation. Repetition in context is responded to by repetition in text, thereby establishing a genre within a socially determined community or group.

Devitt's study (1991) of the nature, role, types, and interactions of texts within the discourse community of tax accounting addresses the way generic texts emerge within discourse communities. Devitt first determined that even though, from six firms studied, accounting seems principally concerned with mathematical calculations, "the accountant's world is as much a world of texts as of numbers" since the profession itself "exists within a rich intertextual environment" (p. 337).

This environment is, on the one hand, comprised of generic texts that emerge and become central to the community since a client-based need is repeatedly expressed and the response given in each instance is similarly repeated. As Paré (1992b) notes, genres occur because they encompass both "the reiteration of textual ***and*** contextual features" (p.2; see Bazerman, 1988). Genres therefore develop within accounting through typified reactions to equally typified or repeated rhetorical situations. Common conventions for writing a particular generic text within each accounting firm become stabilized because each time the same textual response is written, a writer "draws on previous texts written in response to similar situations" (Devitt, p. 338). The ritualization of texts in this fashion then moves outward from concentrating within just one accounting firm to become conventionalized in other firms as writers in each firm refer to the way that texts are written in other companies. Since documents are generally the same for all firms, such consistency stabilizes the broader community of tax accounting and enables the profession to operate efficiently.

Devitt further determined, however, that texts are not just generically intertextual, in that like documents are referenced to the extent that writing conventions are stabilized, but also referentially intertextual. Writers refer to and cross-reference other documents written for individual cases such that, as Devitt calls it, a rhetorical "cluster" emerges, the purpose of which is to meet the needs of each client. Devitt's research indicates that this community not only relies on genres, which derive through intertextuality, to perform its duties, but that the genres themselves are also intertextual. As a result, the tax accounting profession is highly dependent upon texts that, together, constitute a genre system "which both delimits and enables its work" (Devitt, p. 353).

It is thus the relationship of texts as they "weave an intricate web of intertextuality (Devitt, 1991, p.337; see also Porter, 1986) that constrains language users within a community (See Bazerman & Paradis, 1991 for a collection of studies dealing with this concept). Texts reflect what ideas have currency in a community, the specialized discourse the group has adopted, and the conventions needed while writing in order to satisfy reader-expectations. When new members engage with the texts that constitute the ongoing conversation of a community, they learn how to become like others within the group.

Miller (1984), whose work has done much to advance the notion of genre in composition studies, agrees that it is not the form or content of the discourse alone that determines genre, as traditionally argued, but the social action texts are to accomplish in large-scale typified rhetorical situations. Miller therefore argues against a formalist, closed, and highly structured definition of genre, not only because such a classification system is limited, but also because genres are not static, and therefore not subject to such rigid categorical schemes.

> The understanding of theoretical genre that I am advocating is based in rhetorical practice, in the conventions of discourse that a society establishes as ways of 'acting together.' It does not lend itself to taxonomy, for genres change, evolve, and decay; the number of genres current in any society is indeterminate and depends upon the complexity and diversity of the society' (p. 163).

Miller's perspective has strongly influenced perceptions of genre held by most theorists and researchers in composition (Bazerman, 1988; Berkenkotter & Huckin, 1992; Bazerman & Paradis, 1991; Freedman, 1987, 1989; Paré, 1992a; Paré, 1992b; Paré & Smart, 1992; Schryer, 1992; Yates & Orlikowski, 1992; Smart, 1992). Like Miller, their view of genre has moved beyond structure to situate form and other defining elements within a broader socially defined rhetorical situation. Thus, genre has expanded from its traditional view of the repetitions of various literary texts to include "a broad range of repeated social and rhetorical actions, including patterns in the way information is collected, recorded, interpreted, and presented" (Paré, 1992b, p.2).

Such genre-defining characteristics, while they continue to emphasize textual features, now similarly emphasize social context conditions to situate genres as "embedded in the communicative activities among the members of a discipline" (Berkenkotter & Huckin, 1992). From this perspective, "genres can [therefore] be seen to encompass the reiteration of textual and contextual features" (Paré, p. 2). For Miller, a genre is determined when texts, as repeated social actions, are used in response to large-scale typified rhetorical situations. Miller's view of genre as typified social action is strongly influenced by rhetorical theorist Lloyd F. Bitzer (1968) who argues that genre results from typified reactions to recurrent situations important to stabilizing experience:

> From day to day, year to year, comparable situations occur, prompting comparable responses; hence rhetorical forms are born, and a special vocabulary, grammar, and style are established....The situations recur and, because we experience situations and the rhetorical responses to them, a

> form of discourse is not only established but comes to have a power of its own - the tradition itself tends to function as a constraint upon any new response in the form. (p. 13)

Thus, in Miller's view, recurring situations become typified when groups first perceive, establish a need to react, and hence respond, in the same way to a given situation over a period of time. From this perspective, genre then becomes a socially perceived need, and a social response to a socially defined situation. Thus, it is the action of a text - its purpose or task - along with its typified rhetorical situation that, together, provide the basis for defining genre. From this perspective, the predominant recurrence is the social situation:

> What recurs cannot be a material configuration of objects, events, and people, nor can it be a subjective configuration, a "perception" for these too are unique from moment to moment and person to person. Recurrence is an intersubjective phenomenon, a social occurrence, and cannot be understood on materialist terms. (Miller, 1984, p. 156)

Miller thus perceives genre as typified social action and argues that genre is best characterized, not by its regulatory form or content, but by "the action it is used to accomplish" (see Freedman, 1989, p. 14). From this perspective, regularized textual features, as one determinant of genre, are secondary to the initial feature of a repeated social action that leads to a repeated social response, and therefore to genre.

Bazerman (1988), like Miller, has also influenced current perceptions of genre as social action and similarly believes that

> A genre consists of something beyond simple similarity of formal characteristics among a number of texts. A genre is a socially recognized, repeated strategy for achieving similar goals in situations socially perceived as being similar. (Miller, 1984, p. 62)

There are, then, two essential features constituting genre. A socially determined group bound principally by shared social knowledge and discourse constructs, and

repeated actions within the group which lead to a typification in the responses given to those actions. From this perspective, discourse and genre are integrated and appear highly dependent upon one another. Kress asserts, however, that these elements do differ in that discourse speaks of the larger social community while genre determines more specific ways of communicating that discourse in various situations within the community. "Discourse determines what is to be said...genre determines how it will be said in a contextually determined form....Discourse and genre are discrete factors despite the fact that both are constantly present together in linguistic form" (Kress, 1985, p. 29).

Thus, communication conveyed through textual constructs arises from two dimensions - discourse and genre. As Kress explains, "texts are therefore doubly determined: by the meanings of the discourses which appear in the texts, and by the forms, meanings and constraints of a particular genre" (p. 20). Thus it is not only discourse that conveys meaning, but also the ritualized uses of that discourse - or genres - according to the purposes of various social occasions within a group.

Since the conventionalized use of discourse changes according to context and purpose by members within a group, then genre not only governs, in many ways, a writer or speaker, but similarly directs a reader or listener as well.

> A genre provides a writer with a way of formulating responses in certain circumstances and a reader a way of recognizing the kind of message being transmitted. A genre is a social construct that regularizes communication, interaction, and relations. (Bazerman, 1988, p. 62)

Not only does Bazerman explain genre as social action in response to similar social situations, he also explicitly recognizes the roles of readers and writers in dealing with various genres. In effect, Bazerman positions the reader-writer-text triad as central to regularizing a group's communication and interaction.

Thus, while writers in various communities must learn the purpose, form, and conventions required in differing communication contexts, so must readers similarly understand a text's purpose, form, function, and conventions. Readers are therefore also shaped by discourse in that they learn who and how to be as readers within the broad social context of a particular discourse community. The learned norms, values, ways of being, forms of knowledge, and language practices are acquired by readers through ongoing encounters with the texts relevant to their community. Genres then convey what role readers, in addition to writers, should adopt as different types of texts are encountered within the broader community.

Kress (1985) argues that discourse and genre impact a text to such a degree that "to some, in fact a significant, extent therefore the genre and the discourses construct the meaning of a text, irrespective of the writer" (p. 42). But such a construction also requires a reader who reads from within accessible genre, discourse, and ideological boundaries. Thus, this discoursal accessibility, as well as an understanding of who and how to be while reading, is determined by a reader's ongoing engagement and familiarity with genres within a community.

"TEACHING" DISCOURSE CONVENTIONS IN UNIVERSITY

It is evident from the research studies discussed above that writers have many constraints to consider while learning to write following appropriate conventions in their discipline. As McCarthy (1987) determined from studying Dave in three of his college courses, learning to decipher the language of unfamiliar academic territories is much like being a stranger in strange lands; a foreigner trying to uncover the ways of a dominant

group. Educators, researchers, and theorists have all generally become more aware of the need to help students feel less like foreigners in strange academic lands. There is now a greater recognition that a community's knowledge is bound to the discourse and communicative conventions ritualized by the group, and that universities can aid learners in meeting with greater academic success if they are shown how to decode the many linguistic complexities of their disciplines.

This heightened awareness of the need to help students become more competent language-users in the disciplines has lead many universities to adopt composition courses, some of which focus on teaching learners the discourse conventions of academic writing. Many argue that such teaching of academic discourse is difficult for composition instructors since there is no such thing as one academic discourse to teach (Bizzell, 1986; Harris, 1989; Elbow, 1991). Peter Elbow (1991), university writing instructor and researcher, argues, however, in favour of helping students learn the conventions of academic writing in college freshman composition courses providing that discourse is positioned as one form of many discourses with which students should be made familiar. Writing instruction should not, therefore, be restricted to academic writing alone.

Elbow believes that even though many academic discourses exist, most have certain characteristics in common that students could be made aware of in composition courses. In this way, academic writing voices and conventions are examined within a broader framework of many voices and conventions. Students thus become familiar with writing for a variety of audiences using the forms and conventions appropriate to specific readers. By adopting such an approach, Elbow, citing Harris, summarizes:

> What I am arguing against, though, is the notion that our students should necessarily be working towards the mastery of some particular, well-defined sort of discourse. It seems to me that they might better be

> encouraged towards a kind of polyphony-an awareness of and pleasure in the various competing discourses that make up their own. (Harris, 1989, p. 17, cited in Elbow, 1991)

By structuring writing courses as many voices and conventions for many readers, writers then learn to see the pervasive nature of language rather than deal with learning it in discrete contexts. As Kress (1985) argues, "discourses do not exist in isolation but within a larger system of sometimes opposing, contradictory, contending, or merely different discourses" (p. 7). The conventions of these discourses similarly overlap between contexts so it is most beneficial when students learn how to adapt many discourses and many conventions to individual writing situations. As Elbow argues, to isolate certain conventions to specific writing contexts is not always an accurate way of portraying the way language works.

One example of the way in which certain conventions are applicable to more than one writing situation is the need for writers to adopt a fairly impersonal, objective composing style. Students often breach this code of objectivity in their academic writing both by a too frequent use of "I" and "you" (Elbow, 1991; see also Berkenkotter, Huckin, & Ackerman, 1988), and an over familiarity with scholars and researchers by using their first rather than last names when writing. Though writers must learn to balance objectivity and personal subjectivity in academic writing, this objectivity is not germane to academic writing and cannot be considered just a characteristic of academic composition (Elbow, 1991). Many types of texts in various contexts require the same element of objectivity in the writing.

Given that there is no singular set of writing conventions specific to academic writing, and since composition courses are typically comprised of students from a variety of academic disciplines, then teaching a generic set of writing conventions fails to address

the peculiarities of individual discourse communities. Faigley and Hansen (1985), in investigating two students, one in Psychology and the other in Sociology, while learning the writing conventions of their disciplines, determined that generalist writing teachers are not always familiar with the conventions of various academic disciplines. It is therefore difficult for these teachers to instruct learners in the conventions specific to the discourse community individual students wish to belong to.

These researchers observe that different readers read with different expectations, so writers need to learn how to satisfy the reader-expectations specific to their composing context. Readers in the various disciplines therefore rely upon different criteria to assess the merit of texts within their community. Since readers are not the same across all disciplines, appropriate textual features cannot always be learned when using a blanket set of conventions. This is particularly problematic for students when they follow the conventions taught by a writing instructor, yet a professor in another discipline for whom students write may not agree with the way students craft their texts. What's more, when students are instructed by a teacher in a discipline different from their own, they can become confused about the stylistic elements they should use since what they have modelled for them by teachers and in texts in their own discipline may differ from what is taught in general composition courses.

A prime example of just how different the writing in academic disciplines can be is conveyed through Susan MacDonald's (1987) analysis of problem definitions in academic writing. MacDonald argues that academic writing is, in all disciplines, essentially a problem-solving activity, yet defining research problems in the various disciplines operate under different constraints. Some research problems, she maintains, are more loosely constrained than others with more strict definitional codes. Viewed

along a continuum of problem definitions according to constraints, MacDonald places the sciences at one end, where problems are defined according to strict guidelines, the social sciences near it, and the humanities at the opposite end where problem definitions for writers of literary interpretation, for example, are more loosely constrained.

Such differences exist, according to MacDonald, on the one hand because the sciences have common goals for research, and problems are typically defined in ways that make them publicly discernable, finite in number, communally worked upon, and generalizable (p.323). Conversely, a more loosely boundaried research area like literary interpretation does not have the same agreed-upon stalk of problems to investigate. Thus, literary interpretation typically lacks an accumulated, progressive building of interpretation and analysis of individual texts within the discipline.

Fontaine (1988) warns that teaching generalist composition courses can be problematic since such classrooms can revert to a traditional teaching, learning, and evaluation structure whereby teachers impose structured academic learning on students. Current research, theory, and practice supports an approach where the writing classroom is considered a community where writers - comprised of both teachers and students - work together on common writing problems. This means that the knowledge held by the group is a shared, socially determined construct. It also means that students and teachers work together to solve writing problems and concerns. Classes structured and operating on this collaborative premise position teacher and students on a more equitable footing where instructors facilitate and organize learning rather than dispense knowledge. Though what is transmitted to students by teachers may change to deal with academic writing conventions, instructors run the risk of removing any student authority in the

classroom by simply imposing yet another formalist, controlled approach to "teaching" writing. As Fontaine explains,

> Where the conflict arises is in the identification and status of the community members. By focusing on the powerful interpretive community of the academy, a community whose laws and rules can be as powerful and even more entangling than were those of the traditional prescriptive teacher, theorists may create the perception that the teacher is no longer a member of the community of learners in the classroom and consequently destroy any status that the classroom community had established. (1988, p. 90)

Rather than teaching grammar, spelling, and punctuation, as in the past, the elements of instruction become the "conventions" required for acceptable writing in the academy. When teachers once again see their role as the need to instruct proper writing conventions, classroom power is once again restored into the hands of the teacher. The result of such a situation is not one of initiating students into the academy, as is typically argued, but continues to keep them shut out of a place they are still trying to enter (Fontaine, 1988, pp. 90-91).

CONCLUSION

It is evident from the above discussion that, as Hertzberg (1986) claims, a discourse community is really comprised of a "cluster" of ideas. A number of composition researchers and theorists use these interdisciplinary ideas in an effort to establish some defining parameters for their discourse community concept; one that includes the many variants of knowledge, thought, speech, writing, and reading. Although an authoritative definition of the concept does not exist, at least for the present, members of the composition community agree that "the key term 'discourse' suggests a community bound together primarily by its uses of language" (Bizzell, 1987, p. 1). For

most, it is a regularized language and shared language functions that unite members within a community.

In addition to shared linguistic form and functions, common knowledge, goals, and interests also serve to unite members. Thus, a discourse community is comprised of "a group of individuals bound by a common interest who [also] communicate through approved channels and whose discourse is regulated" (Porter, 1986, p. 38-39). According to Bizzell (1982),

> Groups of society can become accustomed to modifying each other's reasoning and language use in certain ways. Eventually, these familiar ways achieve the status of conventions that bind the group in a discourse community, at work together on some project of interaction with the material world. (p. 214)

Marilyn Cooper (1986) echoes Bizzell's claim that shared knowledge and conventionalized language practices unite people into a group.

> Most scholars who use the term agree that a discourse community is characterized by certain underlying assumptions, knowledge, values, and interests that its members hold in common and by the use of language conventions - types of argument, genres, vocabulary. (p. 204)

Several assumptions about writing emerge from the research and theoretical discussion presented throughout this chapter. Since language is central to learning within a particular discourse community, then novices must develop the ability to converse in the conventionalized manner established by the group. They need to know how to articulate the community's specialized discourse following sanctioned, and therefore familiar, forms, and acquire the common interpretive strategies to read like others within the group. So many of the collective's discourse structures become generic and therefore representative of the types of texts that have currency with the group.

Though new members join a community, these participants learn communal conventions from more experienced members within the group. Likewise, even when novices in a particular community bring new knowledge, purposes, or discourse to the organization, they must still learn to position these within the organizational framework and expectations of the dominant group. In many instances, this requires varying degrees of change and modification to existing thought and language structures so new members adopt the discourse and ideology of the majority.

The above discussion indicates that the knowledge, language, and ways of communicating that people learn from their academic or professional discourse community in many respects constitute an identity for individuals. The ways of knowing, being, and communicating developed within a community are not just superficial responses given while fulfilling a role, but actually become the lens through which people view their reality and assess personal experiences. The ways of a community become so internalized by members that, while working to help create that environment by generating knowledge to participate in the group's conversation, they are simultaneously being created by the same social context.

In terms of stabilizing a community, then, members with shared purposes and knowledge operate as a collective. Both knowledge and purpose are shared and identified through a common discourse within the group. Discourse is, however, usually constrained by purpose, form, and function, so discourse, happening as text (either spoken or written), requires certain conventions for presentation. Over time, as purpose, form, and function are repeated often enough by members within a group, this repetition becomes a ritualized genre which subsequently helps to stabilize a community. In other words, when members establish a need or common social action and repeat this often

enough, they customize their response to that action. It is this reciprocity between need and response, both of which occur as repeated social actions, that establish genres within a given discourse community.

Genres emerge within a community because certain needs or purposes for generating textual responses become a repeated occurrence. Members then consult other texts to determine how they should respond to such common requests, thus stabilizing the way responses are shaped. Language-users not only consult other texts to help with the shaping of their own writing, but they also reference other documents to gain additional knowledge about the particular people or issues in which they are interested.

Learning a discourse community therefore requires immersion in an environment where novices can engage in the intertextuality of that social context and develop a thorough understanding of how the community works, principally through its uses of language. Even though such enculteration is more than merely learning a language, so much of the socialization process for acquiring the ways of a community begins with, and is channelled through, the group's discourse. Engaging with the oral and written texts of a discipline's ongoing and multifaceted conversation helps learners adopt the cultural frame sanctioned by that community. The above studies indicate that learners acquire the knowledge and conventions specific to a community when they have language modelled by teachers and texts, plus practice using the discourse and conventions through talk with peers, writing the texts of the community, and receiving feedback from those who know well the constraints of the discipline. In short, learning is highly dependant on context.

General composition courses are restricted in their ability to teach students the conventions of their chosen discipline since the language learned is often not tied to the ideas of one specific area of study. Composition classes are typically comprised of

students from various disciplines, and even teachers usually pursue academic interests different from those of their students, so the relationship between language and ideas cannot be fully developed within a general composition course. The writing conventions learned are thus typically decontextualized from the knowledge and discourse of the community wherein students wish to participate.

Given the concern with teaching writers the conventions of the discipline they choose to enter, writing courses might be more effective and relevant to learners if they were situated within individual disciplines. Writers would then learn to communicate the community's knowledge using its many, dynamic, and contextualized language conventions. The focus of this study is on a specific writing course designed to meet the needs of writers in a specific discipline. This investigation therefore examines one approach to teaching the discourse and conventions of a discipline within a university learning environment. Analyses conducted throughout the research attempt to gauge the effectiveness of both teaching and learning against the social constructionist framework of knowledge, discourse, and communication.

The following chapter outlines the methodology used to study the writing courses in Chemical Engineering where students are "taught" the conventions for writing a technical report as required by their discipline.

CHAPTER III - METHODOLOGY

INTRODUCTION

The literature review just outlined confirms that theoretical assumptions about writing have changed significantly over the past three to four decades. Writing is no longer perceived as a discrete skill conducted in isolation which only few are "lucky" enough to perform. A more realistic view now emerging is to position writing within a context of learned behaviour where writers acquire proper conventions through reading, writing, and constructive feedback. As theoretical underpinnings about writing have evolved, so too have the research methodologies for investigating writers' composing competency. When writing was perceived as an isolated skill, only finished products were examined against defined criteria for determining growth in writing. In keeping with current theoretical views, researchers now rely more on qualitative methods where writers are examined in their writing contexts (see Myers, 1985; Freedman, 1987; and Paré, 1991). In short, writing is a socially defined activity, and the many factors within that social context must be considered when determining how writers develop. A qualitative research approach allows for socially defined factors to be considered.

This research takes such an approach since contextualized social interaction among study participants is key to understanding how students developed their technical report writing ability. This chapter describes in detail the qualitative approach used in this study. It outlines procedures for locating the setting and determining study participants, the multiple sources of evidence used, methods of data collection, and procedures for analyzing the data. The chapter then concludes by outlining two major limitations inherent within the method described.

LOCATING THE SETTING

A number of academic settings for conducting this research within Eastern University (all names are fictitious to ensure anonymity) were examined during the spring and fall of 1991. In early September, the Department of Chemical Engineering was chosen based on four key factors: the intensive technical report writing instruction given to students; the documentation that served as guidelines to help students write their technical paper; the interest in the research by both Technical Paper writing instructors; and the Chair's approval for the research to be conducted within the department.

Chemical Engineering students posed an interesting challenge to research given their emphasis on math and science subjects with limited attention given to writing ability. As well, since writing development is an accumulative, ongoing process which constantly builds on all prior language experiences, it was necessary to limit the focus of this study in some way. Consequently, it was limited to those factors which constituted a shared or common writing context for the writers investigated (i.e., the common experiences of technical report writing).

Language experiences are derived from many factors within a writer's environment such as the language learned and used both at home and at school, books that are read and papers that are written, job-related training, peer and social groups, and so on. Thus, the students in this study quite naturally came to the writing task under investigation already well equipped with notions about composing in general. The students therefore relied on what they already knew about writing, yet were, in effect, asked to augment their composition knowledge by creating a text that conformed to the specifications outlined by their instructor. To varying degrees, as Chapter Four explains,

writers came away from the experience with a greater understanding about the nature and design of a technical report.

Thus, in order to identify what factors within the learning environment promoted this increased understanding, the framework for this investigation is defined by, and generally restricted to, the course within which the report was assigned. Students were followed through the report writing process from the introductory seminar for the course through to the final report submission. Feedback and guidance received during the writing were also examined, as well as other chemical engineering courses which influenced student writing decisions.

Keeping this framework in mind, then, the remainder of this chapter first outlines the theoretical underpinnings of this research and its methodological design. It then describes data sources and the processes used for data collection. The method for analyzing the data is also presented, and a number of writing development features and their characteristics are proposed.

PROGRAM OVERVIEW

Eastern's Faculty of Engineering has existed since 1931, but even prior to its inception as a faculty within the university, Eastern had been educating engineers. The program initially began in 1859 through offering Diploma courses in the Faculty of Arts. In 1871 the program evolved to become the Department of Practical and Applied Science. This Department moved from the Faculty of Arts in 1878 when the university created the Faculty of Applied Science, and, as enrolments continued to increase, the Faculty of Engineering was eventually established.

Currently, the faculty teaches roughly 1800 undergraduates and 800 graduates in one of five engineering departments and three schools (e.g., Architecture). Degree programs are designed to equip students with the skills needed for immediate employment in various industries as well as membership in relevant professional associations. In addition, an undergraduate degree in engineering prepares students to pursue postgraduate studies either at Eastern or other universities.

In order to be accepted into an undergraduate degree program, students must already possess a general and basic science program consisting of two math and science semesters and one humanities or social science semester. For Quebec students, this prerequisite program is typically acquired at the CEGEP (college) level and students entering the faculty are required to complete a seven semester program. Those enroling from outside the province usually enter an eight semester program and complete their basic science requirements at Eastern.

TECHNICAL PAPERS I AND II

During their studies, Chemical Engineering students enrol in two courses, Technical Paper I and Technical Paper II (with paper I a prerequisite for paper II), each worth one academic credit. Students are required to write two reports of approximately 10 pages in length in which they identify a technical problem, develop a solution, and provide recommendations for a practical resolution (see Appendix A). In essence, these assignments are simulations of report writing within professional engineering contexts. Courses are identical in terms of the instruction given, learning objectives, and course requirements. The difference, however, is that Technical Paper II is read and evaluated

far more critically than paper I, since students are expected to apply knowledge gained from paper I when writing their second report.

Both courses are offered in September and again in January, which provides students ample flexibility to fit the course into their individual academic schedules. There are no regularly scheduled classes, but there is a Technical Paper Writing Seminar, averaging an hour and a half in length, each semester that all students enroled in both courses must attend. This seminar is a detailed presentation, given by both instructors, to outline course requirements and expectations.

The teachers first explain that learning to write a technical report prepares students for their eventual workplace, and the nature and purpose of such a report in engineering is identified. Following these preliminary comments, the remainder of the seminar focuses on discussing the format and structural organization of the technical paper. For this discussion, students volunteer their observations about a poorly written report which they have been given to study in advance of the meeting. These random comments are recorded on the chalkboard and subsequently used as the basis for an elaborated explanation about structure and writing style by the instructors. To conclude the seminar, a description of the evaluation criteria used to assess each report, followed by a reminder of submission deadlines, is provided.

For those taking a course during the fall, their seminar is held the previous March and the paper is submitted in September. Similarly, students who enrol and submit their technical report in the January semester must attend the November writing seminar. Since the format and objectives for both technical papers are the same, there is no need to provide separate seminars to paper I and paper II students.

The dates listed in figure 1 for 1992 reflect the format and procedures for technical paper submissions. Students must rigidly adhere to the schedule established by their instructors, and are warned that no allowances are made for late papers.

Submission Schedule
Winter Semester

Deadline for first submission	January 13, 1992
Return of papers	February 10, 1992
Deadline for revision	March 2, 1992
Return of revised papers	March 16, 1992

Figure 1.

During the writing seminar, students are given a detailed document on Course Instructions (see Appendix B; this handout is discussed extensively in the next chapter). This handout, revised each year, if necessary, contains essential information students need to complete their technical report. It covers explanations such as why there is a need for a Technical Report writing course, course objectives, what stylistic format the document should follow, and how the report should be organized and bound for submission. Since students do not meet regularly with their professor, they can deal with questions over the phone; otherwise the handout becomes the principal mode of instruction during the text's development.

Once Professor Dickson and Professor Branch receive the reports early in the semester, they respond to each document and assign a tentative grade of A, B, D, or F. A C grade is not included in this first evaluation in order to make the assessment more decisive in terms of a pass or fail/near fail. Students who receive a D or F must revise and resubmit their reports for a second evaluation, however revision is optional for those

with B papers. Feedback is provided on a comment sheet (see Appendix C; discussed in the next chapter) which details the strengths and weaknesses of each student's text.

Prior to any rewrite, students have the option of meeting with their instructor to discuss strengths, weaknesses, and how to improve the document. Although writers are advised to attend a student-teacher conference before rewriting, the meeting is not compulsory. These conference sessions generally review feedback provided on the comment sheet yet further provide students with more detailed explanations governing why certain weaknesses exist and how to correct errors in their writing. Conference dates are determined by each professor soon after first submissions have been returned. Students then sign up for a meeting, scheduled at 25 minute intervals, on an appointment sheet in the departmental office. Following the conference, students must then address identified problems in their revised copy and resubmit this, along with the original, to their professor in early November or early March. Only one revision is allowed, and the D or F grade is maintained if no significant improvement is evident.

THE PROBLEM

Given that a central purpose of engineering is to find solutions to technological problems, chemical engineers are trained to solve problems primarily in the chemical process industries - chemical manufacturing, pulp and paper, parts of pharmaceutical industries and nuclear energy, and so on. Thus, the program is based equally on physics, math, and chemistry since the application of these sciences is fundamental to a quantitative understanding of process industries. Skills such as problem-solving,

experimenting, and planning are therefore emphasized throughout the program, particularly in the core curriculum.

While the ability to write clear, concise, and accurate technical reports is one of the more important skills an engineer needs, it typically receives insufficient emphasis in most engineering curricula. Even though communication skills are emphasized throughout the degree program, the focus on "hard" or quantitative sciences means that writing competency within the field takes a secondary position.

In order to offset this imbalance between composition and the sciences, the faculty established the introductory and advanced technical writing courses as part of the core curriculum. Students must complete both courses somewhere in their third to seventh semester, however they are urged not to leave either level until the last semester since a one credit course could potentially delay graduation. These technical writing courses therefore provide an explicit attempt by the faculty to immerse students within the writing culture of their profession. They recognize the need for, and value of, an acceptable writing competency within the field, and have taken measures to ensure that this dimension of education is provided to students.

So far, this methodological discussion has focused on chemical engineering and the writing program. These details have been outlined in order to establish the setting and academic framework within which this study is situated. It is important to recognize, however, that this investigation is not meant to establish how effective or ineffective chemical engineering's writing program is for students. In short, this study is not a program evaluation. The prescribed writing program is central to the study because it provides one important framework for students learning to write technical reports. As is true for most disciplines, learning is an immersion process where initiates learn relevant

theories, issues, concepts, and so on, by reading, speaking, writing, listening, and thinking within the context of a defined program of study. Recalling Freedman's study (1987) discussed in Chapter One, the students she investigated acquired the conventions of Law through discussions with both professors and tutors, reading, writing, and receiving feedback on their written texts.

In this particular case, Chemical Engineering students are not only immersed in regular class interaction, but they have the added dimension of a course explicitly designed to teach them the conventions for writing appropriate technical reports. And, according to both technical writing professors, this report is the most common type of document chemical engineers write in the workplace.

As future chemical engineers, then, students are socialized to many aspects and dimensions of their eventual work contexts through an immersion process within the university. The fundamental purpose guiding this study is to understand how students learn to write a specific document according to the conventions of their discipline. The fact that this learning is boundaried primarily by two prescribed composition courses becomes the lens through which that learning is principally examined in this investigation. This focus therefore generates the following questions:

QUESTIONS

1. What background do students bring to the writing task that influences their writing decisions?

    a. What is their attitude towards the writing task and how does it influence writing decisions?

    b. What value do they place on developing their technical writing ability?

c. Do students see the course as just another academic exercise, or do they see it as relevant to their eventual work? How and to what extent do students see learning to write a technical report as a bridge to workplace writing? Do they understand the place of a technical report in industry?

2. What do they understand is the purpose of writing a technical report?

   a. To whom do students perceive they are writing?

   b. Do they have an understanding of what each component of the report is supposed to accomplish?

3. What influence do the various educational components of the course have on helping students learn to write a technical report?

   a. What do students gain from the course seminar? Does critiquing a poorly written report help students learn what to do and what not to do when writing their own report? Are students clear on the criteria against which they will be evaluated? Are the components of a technical paper clear to students once they attend a seminar?

   b. How and to what extent does the course handout facilitate learning to write? Do students use the handout and, if so, to what extent? If not, what guidance do they rely upon?

   c. How useful is the feedback students receive throughout their report writing process? What type of feedback do students receive? Is written feedback on the report itself helpful? Are the annotations written on the text clearly understood by students? Do they enable students to understand why there is a textual problem, and explain how to correct the situation? If no, why not? How useful is the comment sheet for informing students about their writing strengths, weaknesses, and ways to improve? How beneficial is oral feedback? Do student-professor conferences adequately clarify issues, enable students to understand what is wrong, and why, and permit them to correct their text? Is oral or written feedback, or a combination of these, more effective for providing feedback to students?

   d. Do students use any models to help with their writing? Do they rely on the paper critiqued during the writing seminar? Do they use published reports to guide their writing decisions? If so, how helpful are these? Do students rely more on the technical reports of other students, and if so how useful are they?

   e. Do students collaborate to help themselves and/or each other with their report writing? To what extent, if at all, do students rely on people not in the

chemical engineering program (i.e., students in other programs or people already working in the chemical engineering industry) to help with the report? Do other courses affect their writing, and if so, how?

f. How and to what extent does Technical Paper I inform the writing practices of Technical Paper II?

4. How is the issue of genre dealt with in the courses?

a. Is there an explicit or implied understanding of genre on the part of the instructors that can be identified based on their teaching approach? If yes, how do the professors convey their understanding and perceptions of genre to students?

b. Is genre understood purely as text, or is the social context that motivates writers, readers, and texts also recognized? Do students or professors discuss the broader social implications for technical report writing? Do they in any way consider how their social context motivates writers and texts?

c. Is there evidence of intertextuality and intratextuality within the classroom as one context of the overall academic discourse community of Chemical Engineering? If so, how and in what do writers rely on other texts for writing their technical reports?

5. How might the technical report writing process be improved?

a. What are the problems students encountered while writing a technical report?

b. How might teaching and learning methods be improved?

c. Can the methods of feedback be improved so students can better understand and correct errors in their text?

d. Should evaluation criteria be modified and, if so, how should this be done?

CASE STUDY APPROACH

INTRODUCTION

Before discussing the design and nature of case study research in general, it is first necessary to define the "case" under investigation in this inquiry. Several writers

were followed through their technical report learning process so the research is a multiple case study of students. This design allowed for two important analytical levels or components of the data collected. On one level students were studied independently since each had his or her own "story" to tell about the technical report writing experience. On a second level the data were studied to find consistencies among all of the students in this study. Since writers had both a shared academic program context and a technical writing development process in common, the data were examined for characteristic similarities.

GENERAL APPROACH

As a qualitative study, this research is concerned with understanding how and why things happened, and gaining indepth knowledge of a situation, rather than recording an experimental outcome or product (Bogdan & Biklen, 1982; Philips, 1982; Yin, 1984; Merriam, 1988; Anderson, 1990). In other words, this investigation "seeks to describe and explain the world as those in the world interpret it" (Merriam, 1988, p. 170):

> Ethnographers attempt to learn the conceptual framework of members on the basis of boundaries understood by those being observed instead of using a predetermined system of categories.... (Heath, 1982, p. 34, emphasis added)

Since the subjects under investigation could not be separated from their social context, nor should they be since context facilitates understanding those under study (see Mishler, 1979), this research used an ethnographic case study approach. This was particularly necessary since the study is not only subjective and interactive in nature, but also required "direct and face-to-face encountering with the social processes being studied" (Philips, 1982, p. 201). The ethnographic case study differs from other forms of ethnographic research in that the case study is more than a description and analysis of

a phenomenon. Rather, it is a sociocultural analysis of a phenomenon within a bounded context and is concerned with that cultural context (Merriam, 1988). In fact, because ethnographic research strongly parallels writing in that they both emphasize the influence of contextual elements, an ethnographic case study design is suitable for this research.

As is typical of a study of this nature, methods of data collection changed and became more refined, when appropriate, as the study evolved. Because "ethnographers tend to go looking, rather than go looking for something" (Anderson, 1990, p. 150), approaches were tried, and some abandoned, throughout the data collection period (Merriam, 1988). As Schatzman and Strauss (1973) explain,

> Method is seen by the field researcher as emerging from operations - from strategic decisions, instrumental actions, and analytic processes - which go on throughout the entire research enterprise. (p. 7)

Constantly revising and modifying data collection methods and procedures helped facilitate the reflective nature of this study and accommodated not only my own needs, but those of participants as well (Hammersley and Atkinson, 1983). Yet while it was appropriate for research methods to evolve as the study unfolded, this does not mean that the investigation was totally without structure or based solely on personal whim.

As is the nature of ethnographic investigation, a researcher becomes the primary instrument for data collection rather than relying on quantifiable data sources. Data are therefore mediated through a researcher who finds meaning embedded in human experience (Merriam, 1988). Because of this mediation, ethnographic research is often criticized as too subjective and the validity of the research findings may be questioned. Indeed, the fact that there is a subjective element in ethnographic research cannot be denied, and it would be pointless to argue that such subjectivity does not exist within the boundaries of any qualitative research. Researchers, however, bring a conceptual or

theoretical framework to a study that has evolved through accumulated, relevant background knowledge and experience. Assumptions are then constantly questioned and reevaluated in light of what is observed and what is known as the research unfolds; an activity Erickson identifies as "disciplined subjectivity" (cited in Kantor, Kirby, & Goetz, 1981, p. 297). This strategy enables ethnographers

> to examine systematically their own and participants' affective and emotive responses, in order to discover and explain important phenomena. Through this process, researchers discover the meanings and interpretations accorded to events and processes by the participants. The successful ethnographer... develops the ability to maintain a dual identity, insider and outsider, and to represent authentically the experiences of the people being studied. (Kantor, Kirby, & Goetz, 1981, p. 297)

In order to test and verify data as the collection process evolved, seven complementary data collection approaches, discussed below, were used to cross-check findings and strengthen claims for each of the individual data collection methods used (Doheny-Farina & Odell, 1985; Merriam, 1988). In addition, the words of the subjects were constantly reexamined to ensure interpretations became subjectively understood from each person's point of view rather than solely from my own perspective (Davies, 1982).

Moreover, because the data were analyzed as the study progressed, a number of checks for clarification and cross-referencing were conducted with study participants. Participants were asked to verify my account of recorded events through casual interviewing (Lofland & Lofland, 1984). Similarly, transcribed interviews and text analyses were supplemented with informal discussions with students and professors to corroborate my understanding of the data (Yin, 1984).

Suggestions by participants to add, delete, or modify data became a part of the data itself; however, my interpretations were not shared with participants. This ensured

that those participating in the study did not conform to perceived researcher-expectations (Hammersley & Atkinson, 1983; Doheny-Farina & Odell, 1985; Measor, 1985). In addition, data were collected from several study participants. Findings were therefore reinforced through repeated observation and through frequent, detailed consultation with experts within the field of chemical engineering. Finally, research assumptions were checked and clarified through an ongoing analysis of the literature review that outlines the theoretical orientations of this study.

DATA SOURCES

Students

Even though students register for either of the two Technical Paper courses and attend a Technical Paper writing seminar, this does not guarantee that they will submit a report the following semester. For instance, simply because students registered with the department to take the course in January, 1992, and attended the writing seminar the previous November, many withdrew and will register again at a later date. Students often attend a session early in their program and intend to complete their tech paper requirement, but end up delaying a submission until later in their program when they feel they have more time. The department is flexible in terms of when students actually take either Technical Paper course providing both are completed prior to graduation. As a result, there is a high rate of students who postpone the course even though they register for it and attend a seminar.

Because of this flexibility, selecting students to participate in the research had to wait until the reports were actually received by Professors Dickson and Branch. In

January, 13 technical I and 21 technical II papers were submitted. These students then became the basis for selecting participants in the research. Of the 13 students who submitted Technical Paper I, nine agreed to be interviewed and were willing to provide copies of their technical reports.

The Technical Paper II students underwent a sightly different selection process. Of the 21 students who submitted, 15 had completed their first technical report in the September, 1991 semester. These students then became the basis for selecting Technical Paper II research participants for two reasons. First, the fact that these students had submitted Technical Paper I the previous semester reflects the report writing process typically followed by students. Even though they are advised not to leave the reports until the end of their program, most do since there are no measures in place to ensure this does not happen. Second, since the study focused on writing development, students who had only recently completed their first report were more able to recall aspects of their first writing experience. These students had kept both their first and, if needed, second report submission, as well as the comment feedback sheet received from Professor Dickson.

Of the 15 possible students, 11 were willing and available to participate in the research. Of the other four, one person had only to complete the technical report in order to graduate and had already taken a job in Vancouver. Two students declined the invitation to take part in the study, and one was so busy with student activities and personal commitments that it was impossible to establish a mutually convenient time to meet during the first interviewing schedule. Throughout the whole of the data collection process, all nine of the Technical Paper I students were readily available for interviews

and supplied all documentation requested. For Technical Paper II, four students were withdrawn from the study based on complications arising from the second scheduled interview. Thus there was a total of 16 student participants in the study, nine from Technical Paper I, and seven from Technical Paper II.

It should be noted that no attention was given to factors such as language, gender, culture, writing ability, or academic background. Given the diversity of cultures in Quebec, Eastern's student body is as multicultural as the province itself. As well, the university is an internationally recognized institution and attracts students from all over, particularly within Canada and across the United States. By basing participant selection on availability within the time frame of the study, issues like language and academic differences reflected elements inherent to the setting under investigation.

Professors

Data collection principally relied on the case study students as well as the two writing instructors, Professor Dickson and Professor Branch. Both are Eastern Chemical Engineering and MBA graduates who, like the students they now teach, wrote technical papers as part of their undergraduate training. They have been in the chemical engineering field for close to 20 years. Their acquaintance began during their B. Eng. and MBA degrees, and they now have a close collaboration as technical writing instructors at Eastern. Except for a two year interruption by Professor Branch, they have been teaching Technical Paper writing courses since the early 1980's.

Prior to becoming technical writing instructors, they were "clients" for students from Eastern. To clarify, one component of the chemical engineering program requires

students to complete two group projects. These are mock design projects intended to improve an engineering process or to design an entire plant. Clients are enlisted by Eastern from various engineering firms and students must develop their project according to their specifications.

As two client supervisors of student design projects, Professors Dickson and Branch were alarmed that even superior academic students "could not write." When the opportunity to instruct technical writing came along, both engineers accepted. Since then, they have been concerned with helping students become more effective writers in preparation for the workplace.

METHODS OF DATA COLLECTION

Social interaction is an important part of the composing process. Readers provide feedback to a writer's text and, in so doing, participate in that text's development. It became necessary, then, to access the people involved in the writing process, and explore their interactions, in order to strengthen the data collected (Doheney-Farina & Odell, 1985). In light of this, students, writing instructors, and other key respondents (i.e., other professors) were asked to participate. Data collection sources included multiple interviews with students and writing instructors, student-teacher conferences, teacher-taped response to student writing, student text analysis, writing guidelines (i.e., course handout) analysis, comment sheet analysis, and participant observation.

Interviews

Interviews were conducted both with students and professors on an ongoing basis throughout the study. In order not to influence student writing, writers were interviewed shortly after they had submitted their report for first evaluation. A second scheduled interview occurred once students had received their first assessment and been given a tentative grade. For the most part then, students participated in two scheduled interviews averaging 50 minutes in length.

A series of interviews was also conducted with both technical writing professors. It was from these discussions that data such as background information about the course and the assessment criteria for evaluating student work were collected. In addition, professors responsible for the major design projects were also interviewed to clarify the nature, purpose, and design of these courses. This was necessary since they were major course reports written by students which strongly influenced their perceptions about writing.

Interviews were taped to ensure the accuracy and integrity of the data collected. Tapes were then transcribed to make data analysis both thorough and manageable. For all participants, transcriptions were used as the basis for further data collection. For instance, following the first interview with students, tapes were transcribed and clarifying questions were asked about the transcript primarily during the second interview. Transcribed texts with appended questions were given to individuals so they could "recontextualize" themselves before being asked to clarify specific aspects of the text. In other instances, clarification was gained through brief conversations in either telephone conversations or impromptu interviews.

To conduct all interviews, a question guide was constructed but a highly structured, predetermined protocol (as distinguished by Anderson, 1990) was not used. According to Hammersley and Atkinson (1983), most researchers differentiate between the structured and unstructured interview, but, as these researchers maintain, "all interviews, like any other kind of social interaction, are structured by both researcher and informant" (p. 113).

Mishler (1986) elaborates this notion of interviewing as a mutually constructed social event by the interviewer and interviewee. He maintains that interviewing cannot be perceived merely as a verbal exchange because talk is always embedded in context and situation. Instead, interviews should be perceived as a speech event wherein meaningful discourse occurs between two speakers of a shared language. Mishler therefore rejects the stimulus-response survey interview model since such an approach "removes from consideration...the normatively grounded and culturally shared understandings of interviews as particular types of speech situations" (p. 11).

The distinction that should be made, then, is one that differentiates the formal from the informal interview. Formal (Schatzman & Strauss, 1973) or standardized (Hammersley and Atkinson, 1983) interviews are based on predetermined questions and administered to all participants. The reflexive (Hammersley & Atkinson, 1983) or conversational interview, on the other hand, relies on a list of broad areas or "substantive themes" (Schatzman & Strauss, 1973) that simply guide the interview. Non-directive, open-ended questions were therefore designed to encourage interviewees to discuss broad issues. An interviewer's role is to guide but not overtly control each exchange. By focusing on broad issues or thematic areas (Measor, 1985), participants

were able to discuss ideas they felt were important but which may not have been addressed in a standardized interview.

Listening was extremely crucial during each interview, particularly to determine how comments fit within the focus of this research. Moreover, because reflexive interviews do not have a formal conclusion, some issues remained open and were returned to for further discussion (Schatzman & Strauss, 1973; Measor, 1985). Similarly, responses given at each interview directed future discussions to some extent. Because of this, direct questioning was used periodically to test hypotheses or explore ideas as they emerged from the data (Hammersley & Atkinson, 1983, pp. 112-118; Measor, 1985). Because of the reciprocal nature of these interviews, conversations were initiated with students and professors based on observations made during previous interview sessions with both "sets" of subjects. Information could be cross-referenced by comparing accounts given by both groups (Merriam, 1988). Interviews with students and advisors were supplemented with "situational conversations" (Schatzman & Strauss, 1973) or brief, incidental questioning to clarify or elaborate specific issues.

Observations

In order to learn how students acquired the writing conventions of the report, it was useful to complement taped interviews with observations (reconstructed through field notes) conducted during class and student-professor meetings. Actual observations of the learning process were more reliable as a source of data as opposed to relying strictly on "once-removed accounts" from interviews (Merriam, 1988). Two writing seminars and all of the student-teacher conferences were observed. The first writing seminar attended

in November, 1991 was recorded and then transcribed. A second seminar held in March, 1992 was not recorded, but extensive field notes were taken. Similarly, all conferences between students and professors were recorded and later transcribed.

There were three conference sessions, the first occurring in October, 1991, which marks the first formal data collection event for this study. As stated above, all of the Technical Paper II student research participants completed Technical Paper I in the fall, 1991 semester. Student-teacher conferences held that term were recorded, and the transcriptions became an important part of the data collected for the Technical Paper II students in this study. The second and third conference sessions occurred in March, 1992. Of the ten students who submitted Technical Paper I, seven scheduled a meeting with Professor Dickson. For Technical Paper II, three of the eight study participants met with Professor Branch. All of these sessions were recorded and later transcribed.

Given the concern, however, with ethnographic studies that the social system under study not be disrupted (i.e., observer effect), direct, open contact with subjects through participant observation was used (Philips, 1982; Doheny-Farina & Odell, 1985). Basically, there are four levels of observation, varying in degrees of involvement, a researcher can assume during ethnographic research (Gold, 1958; see also Spradley, 1980). The two extremes on the continuum of possible observational roles for a researcher extends from complete participant to complete observer or non-participant. For this particular study, a moderate role between these two extremes was more appropriate where students were observed as they learned, yet they were aware of a researcher's presence and were willing to confer frequently.

Schatzman and Strauss (1973) maintain that it is difficult to act as a silent observer without being observed by study participants. Moreover, subjects can find the presence

of a noninteractive researcher disturbing to the extent that the "naturalness" of the setting under study is distorted (Philips, 1982). "Engaging in minimal, clarifying interaction" (Schatzman & Strauss, 1973, p. 60) allowed for clarifying data collected and put subjects more at ease by discussing the nature and purpose of the research (Doheny-Farina & Odell, 1985). As Schatzman and Strauss (1973) observe, by seeking clarification and meaning of events with participants,

> this type of activity has two distinct advantages: it gets at meaning, and it meets the expectations of the hosts insofar as the researcher is not only an observer, but is revealed as personable and interested; through his [sic] comments or questions his apparent agenda is indicated. (p. 60)

Moreover, by engaging with study participants, actions were less conspicuous and disruptive since

> People in everyday social life carry on precisely this kind of interweaving of looking, listening and asking. Naturalistic research differs only in that these actions are more self-conscious, directed, and intentional. (Lofland & Lofland, 1984, p. 48)

Doheny-Farina and Odell (1985) maintain that researchers need to adopt a dual role of participant and observer mainly because participants have so much authority and autonomy within the study (p. 508). As a participant, it was necessary to see issues from the subjects' perspective and "become" a participant in order to become familiar with the situation under investigation. On the other hand, a certain degree of objectivity was equally necessary in order to observe the situation and articulate each subject's perspective. As Measor (1985) observes, a researcher needs to be "critically aware" at all times in order both to enter a subject's world and his or her perspective, but remain alert to its "configurations" as well (p. 31).

Fieldnotes were used to record observed social processes as they unfolded as well as following participant observation sessions. These notes were written during observations, when possible, and\or elaborated upon following each session as soon as possible. Although students and professors were aware of a researcher's presence, note-taking was not always feasible since it was important for actions to "be congruent [with] the context under study" (Hammersley & Atkinson, 1983, p. 147). Prolonged notes were not, therefore, taken at times when others did not write in order not to appear threatening or disruptive.

Whether notes were written during the observation period or immediately following, they were recorded chronologically and times were periodically noted. Moreover, the following marking system suggested by Lofland and Lofland (1984) was used to differentiate between the types of notes taken: double quotation marks (" ") to indicate exact recall or verbatim entries; single quotation marks (' ') to identify paraphrasing; and no marks to show comments recorded with reasonable recall but no quotation.

Frequent visits, conducted in a variety of situations and settings, were scheduled in order to derive credible, valid conclusions for the study (Doheny-Farina & Odell, 1985). These notes were organized into three categories: observational notes that recorded and constructed what happened; theoretical notes that analyzed activities recorded in observational notes; and methodological notes that served as reminders on how to guide further research (Schatzman & Strauss, 1973; Doheny-Farina & Odell, 1985). Theoretical categories were determined from the data rather than designed prior to data collection. Notes were continuously reassessed in order to clarify the purpose and priorities for further observational sessions (Hammersley & Atkinson, 1983).

Text Analysis

Technical Reports

The technical reports written by each student were a third data source used in this study. These texts were analyzed for essentially two types of information. The first category involved comparing and/or verifying writing decisions made in one or both text submissions for individual writers. For example, some students determined it was necessary to quantify technical data based on feedback received from the professor. The second submission report was then examined to confirm whether or not students had in fact made the necessary corrections. Student reports were also examined for written feedback from the instructors. These comments were used to determine how well writers could interpret the written feedback they had received. It was possible to determine how students responded to their feedback based on how a text was revised. Such an analysis further revealed what responses were most useful to students, and what kinds of writing problems students encountered.

For the Technical Paper I students, nine first submissions were collected and seven rewrote their report. Similarly, of the seven first submissions collected from Technical Paper II students, four revised their texts for re-evaluation. In addition, Technical Paper I reports and rewrites were collected from these students. An analysis of reports from the first writing course provided a developmental view of these writers as they progressed through the writing of both technical reports.

Course Handout

The course handout was also carefully analyzed. This was particularly important because this document served as a primary mode of instruction for preparing a technical report. As mentioned earlier, students attended an instructional writing seminar the semester prior to submitting a paper, and could also access professors by phone if necessary. The course handout, however, served as the principal guide for students while writing their report.

Comment Sheets

A comment sheet is returned with each first submission of a student's technical report. Not only is a tentative or final grade given as feedback to the text, but so is detailed feedback about a document's strengths and weaknesses. This then becomes a principal mode of response to each writer's report and was therefore an important data collection component. Comment sheets were collected from all students for all reports submitted. In other words, while Technical Paper I students had only the one feedback sheet based on their one report submitted, Technical Paper II students had comment sheets from both courses.

Teacher-taped response

In addition to the comment sheets, annotated comments on student reports, and taped student-teacher conferences, both professors were asked to tape responses while they were evaluating each student's text. This provided yet another way to corroborate the feedback given in response to each report. Since the comment sheet required a

written reaction to a text, taped responses enabled both instructors to elaborate on their comments through talk and to justify reasons for requiring various corrections to the text.

ANALYSIS

As is typically the case with qualitative studies of this nature, data were simultaneously collected and analyzed throughout the data collection period. Themes and descriptive categories were therefore determined throughout this collection and analysis process rather than predetermined and imposed on the data (for example, see McCarthy, 1987). Categories and issues for discussion subsequently emerged on essentially three levels during the investigation while immersed in the data.

During the initial data collection phase to become familiar with the situation under investigation, several issues for possible consideration emerged. Considering each writer's sense of reader awareness, for instance, originated early in the study as a probable issue for analysis. From reading the course handout, it became immediately apparent that writers were advised to consider two readers while writing their technical reports. On the one hand, it was suggested that writers imagine an overworked, busy boss as their reader, yet remember that their real reader would be the teacher. Issues surrounding whether or not, and how, this dual readership influenced writing therefore became one highly possible category for analysis early in the data collection process.

Preliminary classifications became more refined and augmented as the investigation progressed. During lengthy interviews with the instructors and students, repetitions in the data began to emerge. Even though these interviews were organized to be guided by key prompts for discussion, in many instances it was unnecessary to cue

interviewees since intended prompts were naturally contained within comments offered. It became apparent that teachers and students were preoccupied with common key concerns so these issues emerged as probable categories for analysis. The fact that similar points arose during interviews strengthens the data collection and analysis process. Writers were given great freedom to offer any comments they chose about their technical report learning and writing process. They were, in effect, invited to tell their own story of the writing and learning process in whatever fashion they chose. Since several common points arose in each interview discussion, the analysis therefore contains an accurate reflection of those issues most important to writers.

The third level upon which categories emerged for analysis stemmed from a repeated and ongoing examination of the data collected for each participant. For the instructors, they each had an interview transcript of approximately 90 minutes in length, the course handout, and a transcribed copy of the seminar's proceedings. Similarly, each writer had a file folder containing all of their documentation. For Technical Paper I writers, their data contained two interview transcripts; their first report submission and, if necessary, the second submission; an evaluation sheet; a transcribed copy of their student-teacher conference if applicable; and the teacher-taped response to the first and, if relevant, second technical report submissions. Each file for the level II writers contained the same as the first level students with the addition of one or, if necessary, two copies of their second report, a second evaluation sheet, and, where applicable, a transcribed copy of their student-teacher conferences for both Technical Papers I and II.

These documents were read repeatedly to identify, refine, cross-check, and verify the analytical categories discussed in Chapter Four. The ability to corroborate the analysis among documents was essential for ensuring an accurate interpretation of the

data collected. For example, writing problems for each report could be identified and verified in three ways: comments written in the report itself; the comment sheet containing fairly extensive written comments, a brief response to a series of questions listed under each of six main assessment categories, and a ranking scale from 0 (poor), to 5 (adequate), to 10 (Good) for each of the six main evaluation criteria; and teacher-taped responses for each report submitted.

Not only did the categories for analysis themselves emerge and become strengthened throughout the research process, but the research framework and questions guiding this study also became more defined as the study progressed (Schatzman & Strauss, 1973; Bogdan & Biklen, 1982; Yin, 1984). Because data were analyzed on an ongoing basis, research questions were refined and reformulated in light of the analysis (Bogdan & Biklen, 1982; Yin, 1984; Merriam, 1988; Anderson, 1990). Similarly, the study's research framework also became more definite given an ongoing review of the literature in conjunction with data collection and analysis procedures.

LIMITATIONS

A key strength of this research is the number of data collection methods used to ensure the validity of the study's findings. Seven approaches were used to cross-reference and strengthen the claims of each data collection method. There are, however, two major limitations within the study which should be recognized. First, because ethnographic research focuses on a specific social setting, studies of this nature are criticized for their lack of generalizability to other situations. However, this research does not make any attempt to generalize; the purpose was to study a particular situation

in depth rather than to find out what is true or consistent for many like-situations (Merriam, 1988, p. 173). It is hoped, then, that those who read this research recognize its contribution to the field's constantly growing awareness of how social factors impact upon writing development. Moreover, readers will perhaps use the findings born out by this research as a point of departure both to investigate other "social" dimensions of writing and to recognize the value of qualitative research for gaining that understanding.

Nevertheless, in spite of the fact that the intent is not to generalize, it is worthwhile noting that although this is an ethnographic case study of students in a single discipline within one university, the writing conventions required by these writers in chemical engineering are relevant to other populations. Many writing conventions required are, in fact, dictated by the engineering discipline at large and it is the university's responsibility to teach prescribed conventions to their students. It is safe to argue, then, that the learning process that takes place in Eastern's Department of Chemical Engineering has some features in common with similar departments in other universities.

The second limitation refers to the student participants in this research. As stated earlier, student selection was based on those who had submitted a technical report for evaluation since students can decide when they want to take either of the two courses. Even if they register for the course and attend a technical seminar, they may still elect to withdraw and submit the paper in another semester. Thus, student selection was not controlled in any way for this research. As a result, the students reflect a wide range of cultural and linguistic variations. While the seminar and supporting documentation are in English, students are invited to write their papers in French if they so choose since both professors are fluently bilingual. It should be noted, however, that all of the students

who submitted a report in January wrote in English. Nevertheless, the writing of students in the study who are not first language English may have been influenced by this difference. Such linguistic differences were considered in the study only to the extent that students themselves noted that language posed a problem.

While such variation may be seen as a limitation of the research, it can also be viewed as a considerable strength. Classes are not typically homogeneous groups so the cultural and linguistic differences inherent within a class are reflected in the study group. Regardless of background, students in Eastern's Chemical Engineering program are still expected to write two technical reports that meet standards acceptable to both the instructors and the department.

The following chapter is an analysis and discussion of the data.

CHAPTER IV - DATA ANALYSIS AND DISCUSSION

INTRODUCTION

As discussed in Chapter Three, chemical engineers are essentially problem-solvers who design solutions to problems typically found in the chemical process industries. Reports that engineers produce, therefore, most often deal with solving a problem related to the operations of various chemical plant processes. Engineers must therefore learn to organize and structure various types of problem-solving texts according to the context or situation that prompts the need for a particular type of document. Stated another way, engineers, as writers within their discourse community, must learn what problem-solving situations require a written response and match an appropriate response to the corresponding writing context.

The first part of this chapter is a description of the requisite degree courses that require students to analyze and discuss, in writing, problems and solutions related to industry. Although they have many lab reports to write as part of their degree program requirements, these reports do not require students to think like problem-solvers who must analyze, synthesize, resolve, and argue conclusions in a detailed document. Lab experiments more simply require learners to follow an experimental procedure described by an instructor and then record the process in a lab report.

The format for these texts follows a standard structure most students learn while in high school. It includes such components as a statement of the experiment, apparatus and materials used, methods followed, and findings. Since writers simply record and report what happened in each experiment, as Margo, a Technical Paper I writer explains, "you're simply regurgitating what you're taught, basically."

In contrast to these Lab experiments, students learn to write three types of descriptive problem-solving reports during their university studies. Each text has a different purpose in terms of the type and difficulty of problem to be solved, so each report is thus written according to different content and structural specifications. Collectively, however, these documents comprise the major part of the learning environment where students are required to use their chemical engineering knowledge, discourse, and writing conventions for producing written texts. In essence, it is predominantly in the three courses described below that students learn to write in their discourse community as professional chemical engineers.

CREATING THE WRITING ENVIRONMENT

PROJECT LABORATORY PARTS I AND II

Project Laboratory is a two part course that requires students, working in groups, to design, execute, and analyze the findings of a set of experiments. These experiments must solve specific chemical engineering problems submitted by clients from outside of the university. During the first semester of the course, students learn how to analyze their problem to determine what experiments are necessary for its resolution. These findings then provide the basis for a written proposal that is submitted to respective clients. The course professor provides students with basic guidelines governing what the proposal should contain, but they consult with the clients themselves for more specifics about document structure.

During the second semester students conduct their experiments and document experimental procedures, findings, and analyses in a final project report. In addition to

this final report, students must also document and record their ongoing data collection and procedures in a laboratory notebook. Throughout this process students must also give five oral presentations, each one given by a different group member, detailing the progress made between each presentation. In conjunction, students must write a memo documenting their progress between each oral presentation and submit this to the professor.

Even though these courses demand a considerable amount of writing from students, the writing itself is not the primary basis for evaluation, nor is it given much instructional attention throughout either semester. According to Professor Weaver, the instructor, the key emphasis is on oral presentation skill development. Thus, orals are critiqued extensively and each speaker is given considerable feedback. Written texts are generally accepted providing they contain the information requested by Dr. Weaver and are readable.

PROCESS DESIGN AND DESIGN PROJECT

Students also do a considerable amount of writing in their Process Design and Design Project courses. These courses, like the project labs, are also problem-solving in nature and are a required degree program component. Students, working in teams, must design a plant or a unit of a particular plant process based on certain specifications. They then do the calculations needed to build their design from scratch which means that they have considerable control over the entire design process.

The structure for these two courses is like that of the project labs. Each design project is assigned by a client external to the university; part one in the first semester

consists of analyzing and planning for the project; part two in the second semester is to develop the process design in its entirety; students submit periodic written progress reports and deliver oral presentations; and, finally, a major report outlining the design process is submitted for evaluation.

The professors suggest that final reports written for both Project Lab and Design Process need not exceed a 20-page length limit. Students, however, typically produce a report 40-50 pages long. Since, on average, there are five people per group, each of whom writes one section of the report, students tend to be verbose in their writing and produce lengthier texts. Little editing is done to shorten or eliminate repetition since students know that structure and length are not major issues with course evaluators.

TECHNICAL REPORTS

Technical reports differ from the large scale design project described above in that students are to address only one aspect or problem of an already operational plant. Companies hire an engineer to resolve a technical problem that interferes with the operation of a plant. An engineer's task is to diagnose the problem weigh possible alternatives for correcting the situation, and recommend the best course of action for solving the problem. As Professor Branch explains at the beginning of the seminar,

> we're looking for a situation, a kind of life situation you have in industry as a trouble-shooter. Here's the problem, and you find me the solution....You have this wonderful thing that doesn't work in the plant and kind of blocks the whole process, and here's your request to go and find what that problem's all about, and find the best solution in order for you - in order for the process to carry on without aftermath of safety, or technical, or costs, or things like that.

This diagnostic process is documented in the form of a technical report which a client then relies upon to determine how a problem might best be resolved. Depending on the nature of a given chemical engineering project, an engineer can be required to write a technical report as often as three times a week. Although reports written this frequently are typically only one or two pages in length, engineers still write ten page technical reports approximately once a month (interview with Professor Branch). Professor Dickson advises students during the seminar that a technical report is the primary writing task of an engineer when beginning a career in the industry:

> The type of paper that we're asking you to produce is probably found in 75-90% of the industrial applications, so, you working as a process engineer in a plant, this is the most likely type of paper that you'll be asked to write.

WHY COURSES IN TECHNICAL REPORT WRITING?

The Chemical Engineering Department attempts to meet a future need of its students by offering two courses in technical report writing. The fact that students must write two reports in order to refine their composing competency reflects an importance placed on technical writing by the department. The instructors explain that, during their careers, they have witnessed how poor writing can impede an engineer's career development. As Professor Branch explains,

> We have seen very very good engineers not be able to communicate their knowledge, they couldn't make a presentation, they couldn't write, their writing style was awful, and they really hurt their career.

Engineers must therefore be able to communicate effectively since it is a primary means by which to demonstrate ability and promote career advancement. Professor Branch

explains this need for effective writing in the workplace in considerable detail to students during the seminar:

> We found out that, in industry, one of the big problems that we saw were engineers which basically were extremely smart, good, and technically competent, but could not express themselves or sell their ideas to people....You find out very fast that, in industry, if you cannot sell your talents,... to gain trust in people that you have the right solution and you know how to correct the problem, if you cannot sell that, ah, you will have problems basically going up the company and ah, in fact, getting other jobs. And so we have seen a lot of people who have done that, not be able to sell their ideas and not being really recognized for what they're worth.

The point is again reinforced in the first section of the course handout. Part one, Why a Course in Technical Report Writing?, explains that "The ability to write clear, concise, and accurate technical reports is one of the most important skills that an engineer needs to develop" (p. 1). The courses should thus ideally prepare students to meet a major writing demand they will ultimately face once they enter the chemical engineering profession. As Professor Dickson explains,

> unfortunately, here in chemical engineering...they're research-oriented uniquely. And um, they tend, in my opinion, to research things for the sake of knowledge and not for any commercial value.... To me, you need that (the research), but you need the other, too.

TECHNICAL REPORT CONTENT AND STRUCTURE

STRUCTURE

During an interview to discuss the technical report, Professor Branch explains that the organization of the report is in part based on research from engineering texts as well as the personal experience of the two instructors during their years of work in

industry. This means that a common, standard format is not used for all technical reports in every engineering-related company. The handout clearly states:

> There are many formats and styles that a technical report can take, and it is always preferable to determine that which one's particular organization requires. This course presents a methodology for one of the more frequently used types of report, that of a structured analysis of alternatives. (p. 1)

Thus, the format students are to follow is best described as a generic structure that is purposely detailed to give students practice with writing a comprehensive technical report. Both instructors reason that once students are familiar with the format developed for these courses, they can then adapt this structure to specific contexts in the workplace.

The format students are required to follow in their reports is emphasized extensively, particularly in the Technical Writing Seminar. This session is basically divided into two sections. In the first part, students are asked to comment on the effectiveness or ineffectiveness of a technical report which they were to examine prior to attending the seminar. As students offer their observations, their random comments are recorded on the board with a number from one to five placed beside each statement. At this point, no one other than the instructors know what these numbers represent. Midway through the seminar, once students have given all of their statements, the session is then directed towards ordering and explaining the randomly numbered items on the board. Teaching then focuses almost exclusively on format and what the teachers expect if learners are to meet with report writing success.

Professor Branch explains that paper assessment is based on six different categories so each number beside a statement on the board corresponds to one of five evaluation criteria. Though there are only five numbers used on the board, there are actually six assessment criteria. The actual first criterion, not listed on the board, deals

with the paper's overall conformity to course objectives which mostly pertain to the report's structure. The five items which comprise this first criterion, listed on the comment sheet (see Appendix C) that students have returned to them once their first submission has been evaluated, include:

1. CONFORMITY TO THE COURSE OBJECTIVES
a) Does the report have the elements of a technical paper?
b) Does it follow the format of the course?
c) Is the topic original?
d) Does it provide a critical analysis of a particular problem?
e) Is the paper unduly long? short?

The last item concerning the paper's length is, like the format itself, strongly emphasized by both instructors. Students are advised that the paper should conform to the 2500 word limit length which "represents approximately 10 typewritten pages" (Handout, p. 6). Professor Dickson pointedly tells students during the seminar that "we expect you to be at the limit - not over, and not under." Both instructors maintain that anything less than 10 pages typically means a topic has not been dealt with in sufficient detail, or indicates insufficient effort. Conversely, exceeding this limit carries the suggestion that "if somebody cannot say what he has to say in 10 pages, he won't be able to do it well" (Interview with Professor Branch).

During the seminar, Professor Branch explains that once a "go/no-go" decision is made for the first criterion based on a general impression of the paper, the instructors then assess the report against the five remaining criteria. These evaluation categories are then elaborated by Professor Branch as he explains what they are looking for in each criterion. Three of the five criteria relate to report structure and content so Professor Branch discusses the purpose for each report section and describes specifically how the various parts should be structured. For instance, the second criterion, though given the

number one on the chalkboard, is to assess the statement of the problem in the report's introduction. As Professor Branch explains to students,

> you should take the first one, which is all the ones that you have there, they are mostly related to the problem. And it's - what we'll be looking for, why that you are suddenly being asked or do you have to take a look at that problem, how specific is it...Sometimes we end up with people presenting a 2 1/2 page introduction in a ten page paper. Now that's improper; usually an introduction is half a page. That's really the maximum.. Now, in the introduction, what you should do is basically to say what is the problem...why it suddenly becomes an urgency if somebody looks at it, and what is your mandate. And then briefly introduce what you're going to talk about. So very very short, it doesn't talk about what process and what type of condition that process is....

Similarly, in the event that students need to provide a background section to elaborate their introduction, they are told that

> with the background, you come around and you explain the environment of the problem so that you can cause the person who reads the paper to know where it actually fits as a whole, and describe things like conditions - process conditions, or if it's an issue about environment, what is the law, etc. And there again, as I say, it should be in the paper or in the appendix; don't write a dissertation where the background takes half the paper, just put the essentials, and everything which is really not necessary for the reader to know, but would be nice if ever he wants to find out more about it, then you put it in the appendix. So, first thing is introduction, the second is having a background in the paper....

In both instances, the instructors tell students how to structure their reports and emphasize the importance of following the format requested. They further explain rather precisely what type of information should be contained in each section of the report outline. The remainder of the seminar continues in this manner until all sections of the report have been explained in considerable detail. The report format, and how each section should be written, both in terms of length and content, are thoroughly reinforced throughout the presentation by the two instructors.

The required report sections, as well as the grading criteria, are also discussed extensively in the course handout (see Appendix B). The comment sheet (see Appendix C), which students receive once their first draft has been assessed and returned to them, is actually a list of the six grading criteria dealing with the form and style of the technical report. The feedback students receive thus further enforces the significance placed on learning the teachers' required format. It is evident that writing to provide the required format is repeatedly reinforced for students throughout their report learning process. Before even entering the first of the two writing courses, many students already assume there is a strong significance placed on form based on hearsay from others who have already done at least one writing course. This is evident from the comments found frequently in the student interview transcripts that "everyone knows" or "people who take the course will tell you" that supplying the proper format is fundamental to success.

Student perceptions of the significance of form in relation to any other aspect of the writing, in particular content, is thus shaped and reinforced throughout the entire learning process. In the handout, students are advised that "The following outline should be followed unless there are special reasons for modifying it" (p. 7). This outline, from section eight of the course handout, is provided below to demonstrate the detail and emphasis placed on following structural requirements. It includes explanatory comments, marked with an asterisk, to ensure future discussions about technical report organization are clear. (Appendix A is a complete report by Jim, a Technical Paper II student).

8. <u>FORMAT</u>

<u>TITLE</u> - should be chosen with care to indicate as specifically as possible the content of the paper.
KEEP IT SHORT.

ABSTRACT - a capsule version of your paper, stating objectives, methods of solution, conclusions and recommendations of your paper as concisely as possible (50-150 words maximum).
*Students must submit two copies of their abstract since one is kept on file.

ACKNOWLEDGEMENT - should briefly indicate if this work was the result of a summer job. Where? What company? What were your duties? Who helped you with the material? Etc.

TABLE OF CONTENTS - should list the major headings and sub-headings with page numbers. Avoid too-extensive a breakdown.

LIST OF ILLUSTRATIONS - should list all illustrations with page numbers.

*The above items, except the table of contents and illustrations, must all be written on a separate page.

INTRODUCTION - must include a clear statement of the problem as well as the objectives of the paper. It may also include an outline of relevant background to the specific topic.

BACKGROUND - A separate background section may be used but only if preliminary information is included which is essential to understanding the paper. If you are uncertain whether the reader will understand your background information and want to write more explanatory or descriptive material, this should be placed in an appendix.
*Students must decide if there is a need for a background section, if it should be included in the body of the paper, if additional information is required in an appendix, or if the entire section should be attached to the back as an appendix.

DISCUSSION - must present a logical progression of analysis to lead the reader from the problem statement to the conclusion. This section should be subdivided into the required and appropriate headings such as:

Method of analysis

*Students outline their approach for making a final device selection. This section is essentially the same for all writers since they are given a procedure to follow (outlined in the following sections). The only individual aspect of this section is that students share any overall assumptions they have about their analysis with readers.

Criteria of Selection

*This section consists of two lists of criteria comprised of the essential criteria, or the criteria that the selected device for correcting the problem must meet; and desirable criteria, which are criteria that are desirable, but not essential, for the selected device to meet.

Alternatives

*All alternatives considered in the analysis of selection identified and briefly discussed in this section.

Analysis of Alternatives

*This section essentially combines the **Criteria of Selection** with the **Alternatives.** Each alternative is first analyzed against the essential criteria, and those devices which do not meet the essential criteria are immediately eliminated from the report. A comparative analysis table is required at the end of this section to summarize the discussion. There must be at least two acceptable solutions based on essential criteria so students go through the exercise of measuring devices against the desirable criteria. Students must weight and prioritize these criteria in order for one alternative to emerge as superior to all others.

Results

*Here students briefly state their findings from the above discussion.

Assumptions Made (and their limitations)

*Any assumptions relied upon for the above discussion should, at this point, be identified, and any limitations explained.

CONCLUSION AND RECOMMENDATIONS - must present an answer to the problem stated in the introduction. Together, the introduction and conclusion should make sense without the rest of the paper. The conclusion may also include additional findings which you did not seek at the outset, but which resulted from the analysis nonetheless. Please be sure, however, to not introduce new information, such as new selection criteria, at this point.

Be sure that you recommend a course of action. Be firm and positive. Don't leave it up to the reader to try to figure it out. You must also perform a "POTENTIAL PROBLEM ANALYSIS" on your final solution to determine what weaknesses are inherent and what could be done if any of your assumptions turned out not to be true. In other words, determine what could go wrong with your solution and if it did, what would you do about it.

REFERENCES - Every reference from which the information in your paper was obtained must be specifically referred to in your paper and listed at the end of your paper in alphabetical order or in order if first mention.

Each reference must consist of the authors' names, title of the paper or book, name of the journal, volume, number, pages, publisher of the book, and year of publication. Look up any standard journal for acceptable formats. Material transferred directly from any reference must be presented in your text in the form of a quotation.

FIGURES AND TABLES - should be used when they will help to clarify, illustrate, or summarize pertinent information. All figures and tables must be specifically referred to and fully discussed in your text. This is particularly true when discussion processes or

equipment where it may be useful at the beginning of your discussion to refer to the flowsheet or drawings.

APPENDICES - use them sparingly, and only if needed
(Course handout, pp.7-8).

CONTENT

Students are given two options for selecting their topics - based on summer work experience, or through literature research. Students are advised that the best topics come from summer employment where they can identify a real worksite and propose how some aspect of an already familiar operation might be improved. If, however, they do not have relevant work experience, students can select a topic of personal interest and review the literature until they are "familiar enough with it to write about it authoritatively and intelligently" (Handout, p. 5). In either case, writers must be familiar enough with the technical aspects of their subject to write an authoritative, intelligent, and non-superficial report. As Professor Branch summarizes during the seminar,

> we're hoping that if you have a relative job, if you could use data or information from your job, and, if not, do some research in the library or anywhere where it's pertinent, but don't make a superficial paper.

For those writers who conduct a literature review, they must create a hypothetical worksite to situate the problem they investigate in the literature. During an interview with Professor Dickson, he explains that

> typically what they'll do if they have to do a literature research, they'll say I'm interested in something like um, water desalination, ah, removing salt from sea water. And there's a number of different processes used around the world, so they would establish a problem which would be generic in the sense that I want to choose the best system given this capacity and this location, like Israel.... That usually is a key factor in the selection process, you know, if you were to build a desalination plant here you'd use a

> completely different set of criteria then you would if you were building it in the Middle East.

To help students focus their topic selection still further, writers are advised they should not use material from a previous paper, project, or course. Other than noting that "trying to 'kill two birds with one stone' rarely achieves the objectives set out for this course," students are given little explanation governing why they should avoid relying on material from other courses. To help students differentiate the technical paper from other reports they have written, however, students are warned to "**AVOID SELECTING A LAB PROJECT** as past tendencies have been to produce a lab report - which is not acceptable." Similarly, writers are advised that "a DESIGN PROJECT which systematically runs through masses of calculations is totally unacceptable" (handout, p. 5). Students are periodically reminded throughout the seminar that a technical paper is not like either a lab or design report.

INTEGRATING FORM, CONTENT, AND WRITING STYLE

The instructors explain, then, that structural organization is highly significant to the writing of a technical report. To meet with success, however, students must not only follow the format provided, but adopt a writing style that is both succinct and persuasive. On the one hand, the text must be written in a manner that ensures writers lead their readers to agree with conclusions argued in the report. It must also be written well in terms of grammar, sentence structure, paragraphing, and punctuation. As Professor Dickson explains during the seminar, "if the spelling is poor, and the grammar is poor, and it's hard to read, we don't read it, and you'll get it back without being read." Professor Branch similarly advises students to "be concise; sentences are short. You're

not writing an essay, you're writing a technical paper, so make sure the writing is attached to the format."

The problem addressed, or report content, however, is treated more abstractly by the instructors. Students are simply told that problems should deal with some practical problem relevant to a particular workplace. They are reminded that they are writing for "somebody who has an ear, or technical background and knows exactly what you're talking about, or someone who is aware of what the problem is all about" so they should be cautious about how technical data is handled in the paper. The instructors further caution students to "put meat in your paper. Don't try and stretch...information over ten pages. If you don't put enough material and it goes really fast, then it becomes very obvious...that you're trying to waste space."

During separate interviews, both instructors explain that little emphasis is placed on technical content during evaluation. Their chief concern is that students learn how to organize and present ideas as well as develop a clear, succinct writing style. During his interview, Professor Dickson explains the balance between form and content as perceived by the instructors:

> We don't put a lot of emphasis on technical content because we want the students to concentrate more on the writing and the organization aspects.... We don't accept trivial stuff either.

In a separate interview, Professor Branch reiterates this lesser emphasis placed on technical content and states that the "course is not designed to check if people are good engineers or not." The instructors, according to Professor Branch, assume writers "know their stuff" so technical content is judged according to whether or not it makes sense within the paper. As he explains during the seminar, it becomes evident in the writing when the technical data have been poorly handled in the text: "if it's off the wall or not

graded properly or basically nothing to do with, or not possible to have such results, for example, then it shows in the technical solution."

Both instructors therefore read each report assuming that students are knowledgable about their subject area. Professor Branch maintains that it usually becomes evident from the way a topic is treated when students are not familiar with their content. As Professor Dickson states during one of his interviews:

> If he doesn't know his material, it would show in the paper. It's quite clear it would show in the paper, or, even more, when we talk with the person, you can make a good clean distinction of does the person know his or her stuff or not.

Even though the emphasis placed on content is much less than that given to structural requirements, students are still expected to handle their subject matter both accurately and authoritatively. Not only must students present a paper in which they appear highly knowledgable about their material, but any calculations used must also be integrated and shown as relevant to the discussion. They are similarly expected to be accurate in method and arithmetic. According to Professor Dickson,

> What happens is, to fill space, to try and impress, what engineers do is they try to put a whole bunch of calculations. They figure the more calculations, the more stuff in the appendix, the more impressive the report is....They'll do a pump selection ... and then, in the appendix, they'll photocopy the manufacturer's brochures including 14 pages of, you know, specifications for pump sizes and dimensions and everything, of 6 manufacturers, which is totally irrelevant. Likewise, they'll put in reams and reams of calculations that are irrelevant to the selection that's there. They're neat calculations and they may be very necessary to do, but ultimately they're not particularly pertinent or relevant to the particular topic.

There is thus a balance between form and content that needs to be established in the report writing even though students are free to select their own topics with no stated restrictions on how simple or complex a problem should be. They need to recognize,

however, that topics must conform to the format expected, so the problem chosen must lend itself to an analysis of various possible solutions against specific and quantifiable essential and desirable criteria. For the instructors, report content is considered correct, and questioned only when there is an obvious error. In terms of the way the report is written, students must be succinct and persuasive.

This form-over-content relationship is not, however, stated explicitly during either the seminar or in the course handout. Students must infer from the handout and comments made during the seminar what balance is required to handle successfully the relationship between form and content. They need to understand the overall significance placed on form, yet select a topic that adapts well to that structure, ensure accuracy in device specifications and calculations, and further write in a direct but convincing style. Based on a study of both interview transcripts for each writer, the extent to which students understand this implicit balance between form and content expected in their writing strongly influences writing success. Student perceptions of this relationship are discussed in the following section.

STUDENT PERCEPTIONS OF FORM AND CONTENT

TECHNICAL PAPER I

Six of the nine Technical Paper I writers followed the advice of their instructors and selected a problem from their summer employment. They similarly used this familiar worksite as the basis for the hypothetical work setting used in their report. Given the students' actual knowledge and experience with the situation chosen for the report, these

writers knew their final outcome and recommendation before the technical paper was actually written. As Dean explained,

> I already knew where it was going. Like I really didn't have to make a choice, I just made it so that my choice was the right one, what I knew already.

This *a priori* knowledge meant, however, that these writers also needed to research the literature in order to include additional device alternatives from which their known solution could be selected. This posed some problems since writers engaged in a rather lengthy trial-and-error process to test and select additional device alternatives. It was at times a trying exercise since devices selected had to fit the overall direction of the discussion and complement the pre-determined alternative identified in the conclusion.

Two of the three remaining writers in this group selected a topic from an engineering course taken earlier in their program. In Frank's case, this meant that he had little research to do since he already knew a considerable amount about his topic. He simply needed to review the literature in order to discuss his alternatives in greater detail. Similarly, although Susan did not know a lot about her topic, she wanted her research to be relevant to more than just the Technical Report course. She therefore selected a part of her Design project to investigate in order to inform her work in this second subject as well. The final writer, Sam, relied on extensive literature research both to identify and situate his problem. These three writers were the only writers who did not rely on summer work experience to select a topic, and were similarly the three writers to pass their first draft with a B grade. The other six writers all received either a D or an F on their first submission.

While writers differed in topic selection, eight of the nine writers in this group clearly stated a need to deliver the correct format. They understood that providing the

structure outlined by Professor Dickson was essential to writing a successful paper. The difference among these eight writers, however, is the level of technical discussion they gave to their content because of differing assumptions about the balance required between form and content. Writers varied in the extent to which they understood that form should outweigh content, so their papers varied in the degree to which topics were discussed from a technically suitable level and perspective. Some writers assumed that what they actually wrote about was far less significant than ensuring they delivered the correct form. Similarly, others saw a need to treat their data in a more technical and detailed manner in conjunction with following the proper organization.

Three writers, Frank, Sam, and Susan, ensured content was delivered in a clear, concise, and non-superficial manner sufficient enough to warrant a B on their first draft. Susan and Sam chose not to revise their papers so they received a B as their mark for the course. Frank, on the other hand, revised his text to earn an A on his final submission. All three of these writers not only knew that their topic needed to follow the organization given by Professor Dickson, but they also understood how to balance form with technical content well enough to meet teacher-expectations. As Susan observed, her professor first outlines the specific criteria to be followed, and then, to select a topic,

> you have to shop around to find something that fits that (the form). If you try to do something that doesn't fit I don't think it's going to meet with a lot of approval.

These writers recognized that form was of greater concern to the instructors, however they also knew the topic should be treated in a technical and convincing manner - even though writers did not always possess extensive or sophisticated knowledge about their subject. As Sam explained,

> we don't have the background to have a justifiable process...so the process isn't very important as far as I'm concerned. It's more the way you set it up, the way you cut down your alternatives, try to be as succinct as possible.

In general, Sam recognized that his topic required a sound technical treatment even though he did not possess extensive background knowledge about the process he investigated. He similarly understood the need to be succinct in terms of his writing style. Sam's overall assumption that emphasis be placed on form rather than content was confirmed during his student-teacher conference. In that meeting, Professor Dickson instructed Sam to estimate his device limitations, providing he stated that numbers were approximate, when actual numbers were unavailable to quantify data. Susan similarly understood how to manipulate her information in order to satisfy the content demands of the assignment. As Susan claims, "when you hit a wall, just sort of make an assumption. It's easier if you invent your own company."

Three other students in this group, Margo, Carrie, and Dean, emphasized form to the extent that content was treated too superficially, which resulted in a D on their first submission. They, like Susan, Sam, and Frank, similarly recognized that format was the predominant concern of their instructors, however they did not place enough emphasis on the technical treatment of their topic. Margo's initial perception of the importance of form reflects the extent to which these writers emphasized form in their own learning:

> Well, I think we're to follow the format, and being able to write the report, because we're marked on how we write it more than on what the topic is or what - it's not like what we found out that's so important, it's how we write it and how we structure it.

In Margo's view, along with Carrie and Dean, the format is the predominant concern of their instructor.

Carrie, in fact, was extremely concerned about satisfying the structural demands of the assignment. Although the company she borrowed her problem from actually purchased two devices, she only chose one alternative in her assignment since, had she selected two, "I think I could get really slammed with that." Her concern comes from the instruction to have at least two alternatives against which to measure desirable criteria once most of the devices have been eliminated based on the essential criteria. Carrie worried that, had she selected two solutions to her problem instead of one, she might be penalized by the instructor. Carrie even worried about factors such as the length of her abstract. She was concerned that it might be too long because she exceeded what she understood to be a five sentence length restriction she thought was suggested in the handout. She explained that "he's so direct in everything else" that she feared Professor Dickson would probably criticize the length of her abstract.

The following abstract from Dean's first report is indicative of the level of superficial treatment given to the ideas of these three writers. Dean's report deals with selecting an instrument to monitor the pressure of a second instrument called a die. In this process, plastic is melted, pushed through a tube, and forced through the end of a die to mould plastic polymers, or little beads, into desired shapes. The instrument Dean chose to select is one that monitors the die pressure as it extrudes the plastic polymers. His abstract, as he explains in his first interview, should summarize his problem, operational constraints, and final decision:

> It is required to measure the die pressure in a plastics extrusion process and a suitable method is to be found. Due to the high pressure and temperature conditions of the process, pressure measurement by elastic-elements and electrical elements are the only alternatives. A comparison of the different devices proposed will show that the 300 series Melt Pressure Transducer by Omega Inc. is the best choice.

Dean, as well as Margo and Carrie, were able to revise their papers well enough to earn an A on their final products. Dean's revised abstract again reflects how he, like the other two writers, treated complaints of superficiality from their instructor. This second abstract contains far more background and qualifying information that better explains his problem, the constraints his solution must meet, and his decision.

> An important parameter in the operation of a plastics extruder is the material pressure at the extruder head. This pressure is used to determine the flowrate of the extrudate which is regulated to obtain a product of uniform shape and quality. A suitable method is to be found to measure the die pressure in an extrusion process. Due to the high pressure and temperature condition of the process and the need for automatic control, conventional pressure measurement by manometer or dial gauges is not possible. Electronic pressure transmitters are the only alternative. A comparison of the different devices proposed will show that the 300 series Melt Pressure Transducer by Omega Inc. is the best choice.

Clarence and David, two of the remaining three writers, had an even narrower perception about the importance of adequately developed technical content in conjunction with using the correct form. These writers, however, sacrificed content to such an extent that Clarence received an F on his first submission and David received a D. Clarence, for example, assumed the focus was entirely on format and that it mattered little what he actually wrote about:

> I was wondering at the beginning if the teacher was expecting some - if they were putting the emphasis on the technical or um, the format, or on the form - how it was written - so I just assumed it was more on the way it was written because that's the purpose of the paper.... I put all the effort on how I'm going to write it more than what I'm going to write.

Thus, while he relied on his summer job for a topic, "it was nothing about engineering. I just found something that could be a technical problem." He admits, during his first interview, that he conducted little technical research for his paper because "it would take too much time, so I just looked at the surface...I didn't get any really good conclusion."

Overall, Clarence's assessment of his paper, before receiving any feedback, is that "from a technical point of view, I'd say my tech paper is pretty bad, but ah, as far as writing...well, it'd pass."

In his evaluation, Professor Dickson informed Clarence that he had not only given a far too superficial treatment of his data, but that he had also divided his criteria into three categories - design, operating, and decision - rather than the required essential and desirable classifications. Moreover, Clarence failed to discuss his alternatives in relation to the criteria outlined for his device selection. Based on his evaluation, Clarence revised his perceptions to conclude that

> I thought the emphasis was more on how you write it than what's in it.... But [now] I think his emphasis was more on the content than on the format.

Even with feedback from Professor Dickson, Clarence still does not understand the balance required for both form and content. He moves from assuming the entire focus is on form to believing the emphasis is on content. Even, however, in their attempts to revise the content of their report, both Clarence and David earned only a B+ on their final submissions. Their failure to substantiate claims thoroughly enough and provide sufficient detail about their process in their second submission is reflected in the two versions of Clarence's **Assumptions Made** sections. The purpose of his report was to select a device for cleaning up small gasoline, diesel, and oil spills in a marina. In his first report he states that his assumptions while writing his paper included the following:

> **2.4 ASSUMPTIONS MADE**
>
> Since no chemical description of the chosen dispersants was available, it will be assumed that the dispersants respect the federal standards for toxicity:
>
> Total aromatic hydrocarbons: 3%
> Total chlorinated hydrocarbons: 0.05 mg/L
> Mercury: 0.005 mg/L

Cadmium: 0.01 mg/L
Lead: 0.05 mg/L
That is, they must contain less than the indicated amount.

In response to Professor Dickson's concern that the paper was "totally lacking in substance and borders on the trivial" in general, as well as to the direct query, "how valid is your assumption?" written in his first submission, Clarence offered the following revised version of his **Assumptions Made** section. It is evident from reading this second draft that Clarence fails to substantiate his claims, principally, it seems, because relevant documentation was unavailable.

> Since no chemical description of the chosen dispersants were available, it will be assumed that the dispersants respect the federal standards for toxicity as stated in the essential criteria. Any dispersant that would not meet these requirements would be identified by the Federal government and thus would not be available on the Canadian market.
>
> Only small spills will be considered since the majority of recreational boats can contain a limited amount of hydrocarbon. The maximum volume of spill is therefore set to 30 liters.
>
> Since no data is available on gasoline or diesel spills in the literature, it will be assumed that the results on gasoline/diesel recovery will be the same as for oil (with the exception of absorption which is known to be ineffective on gasoline or diesel).

In Professor Dickson's teacher-taped response about Clarence's second submission, he notes that Clarence has made considerable revisions to his paper, however there is still an overall vagueness to the paper.

The final writer, Randy, differs from the other eight writers in that he assumed the focus of the report to be entirely on content rather than form. His topic was based on previous work experience although he explains that he was highly interested in this particular problem even before he went to work. Randy was most enthusiastic about researching his problem in order to provide his former employer with what he hoped

would be highly valuable information. He therefore wrote his paper as he thought a business paper should be written, so he discussed, in detail, both the advantages and disadvantages of each device alternative as well as their costs.

As a result, Randy not only neglected to meet structural expectations, but failed, in many respects, to meet content requirements as well. For example, his device alternatives were not defined adequately, ideas did not develop and progress in the paper, arguments were not supported with evidence or fact, and a convincing conclusion had not been reached. Randy's paper was so far "off track" that Professor Dickson chose not to evaluate many sections of the report until it had been revised. He was thus given an F on his first draft. Based on his student-teacher conference, Randy understood that most of the content needed was actually included throughout his report; however, he needed to delete unnecessary information and reorganize remaining sections to conform to the technical report format. During his second interview Randy states that

> Basically the format of our paper makes a lot of sense. Like, what's your problem, how do you define it, what is the criteria you will base it on in order to eliminate all the alternatives. It's like a natural, commonsense way of doing it.

Though Randy was able to revise his paper rather extensively for his second submission, and Professor Dickson congratulated him on his effort, he still received only a B since he continued to have a problem with lack of supporting detail.

TECHNICAL PAPER II

Based on an analysis of the technical reports, comment sheets, and the two interview transcripts for each student, by the time students write their second technical report they have a more refined ability to balance form and content. Of the seven writers

in this group, six passed their first submission by receiving either an A or B grade. Based on feedback from the comment sheets, these six writers generally understood the technical level at which the content of their paper should be written in conjunction with following the required form. As Bernie observes, the paper should be "reasonably technical," but fit the format or else "there's no go on that whatsoever."

All of the writers, including Aaron, the one writer to fail his first submission, selected topics carefully to ensure they suited the required format. Based on his first report writing experience, Aaron repeatedly referred to the professors as "really picky" about satisfying all structural aspects of writing a report. He attempted to address all organizational issues while writing Technical Paper II, particularly in light of the criticism against his Technical Report I that "your entire treatment of the subject matter is far too trivial and simplistic."

In spite of his efforts, however, Aaron received a D on his first Technical Paper II submission because he continued to have problems with form and content even though Aaron himself assessed his text as "a good paper [because it] fits a better format." On Aaron's evaluation report, Professor Branch explains that

> From the way you label the criteria and relate to them during your analysis, it is not evident which ones are desirable and which ones are essential. Sources and reasons for the given process limits are not provided adequately. Alternatives are not well described.

He similarly continued to have difficulties with the internal organization of his text, in terms of the structure given to the various sections within his report, and also experienced problems with his writing style. In response to Aaron's introduction, for example, Professor Branch comments that

> The introduction is not well written. It goes from a broad statement, to a specific issue, introduces a work plan, then goes back to a broad objective with precise but incomplete criteria list. Need to address both the structure of the introduction as well as its content.

It is evident from the feedback that Aaron continued to experience difficulty with both the form and technical treatment of his data. His revised text, however, improved enough from his first submission to prompt the comment from Professor Branch that it was a "good paper." Continued weaknesses with grammar and writing style, however, meant that Aaron received only a B+ for his final submission.

Unlike Aaron, the other six writers did not experience major problems with either form or content. Like Aaron, these writers knew from their first report writing experience that getting the form correct was extremely important to meeting with success in the course. Connie, Jamie, and Angie, the three writers to receive an A on their first submission, all had a highly practical approach to the writing task in terms of selecting a topic that would satisfy format requirements. These writers chose a "simple" topic to write about based on the books they found which were geared specifically for selecting equipment and devices for various engineering processes. In Jamie's case, he explains that he

> just went into a book about all kinds of things you have to measure in engineering and I just chose one....
> I went to the library and found a book about online process measuring equipment. The first book in the volume was all different cases where you need process measuring equipment. It gives a two page description of all kinds of different cases where you have to select something, so I just used their situation and went through more books finding all the different options for the problem.... And then, to be honest, because of the format of this paper, I just looked at my options and kind of selected criteria that I knew were in the bounds of the most of them.

For Jamie's Technical Paper I, however, he had selected a more complex topic. The problem he chose to write about for his first paper was derived from another subject,

and, because he knew he had to measure something in industrial applications, he wanted to become "pretty familiar with the operation." Jamie received a B on both Technical Paper I submissions but an A on his first draft in Technical Paper II.

Angie relied on the same topic selection method for both Technical Papers I and II. For her first report, Angie typed in "Selection of" into the library computer system since

> basically that's what you're doing. And then there was a book like selection of a pump for a spill clean-up operations and there were different headings like on land, on sea, and I just chose a situation from that and basically everything came from environment books.

For her second report, Angie remembered that the books mentioned "other methods of cleaning up" so she took a topic related to her first report and researched the new subject in the same manner as the first. Angie received a B for Technical Paper I first submission, an A- for her revised text, and an A for Technical Paper II first draft.

Connie relied on her summer employment as the basis for her Technical Paper I. She explains that

> when I did the first one I didn't really know what to do and I was working...and the people there said why don't you try this? It was ion particle size that I analyzed...and I had access to a good library there and was able to get a lot of information.

For this first writing experience, Connie had problems with both form and content to the extent that Professor Dickson said her paper "Need[ed] a major overhaul." She revised this first technical paper from an F to a B+.

Connie's topic for Technical Paper II, however, came from a book supplied by an engineering company:

> One of our classmates had written away to some companies and one of them had sent him five big books and they were all on different things, and a few of us just took one of the books, it's just like a catalogue but for

> each thing it will be however many different instruments, and I just pulled a whole bunch out of there.... It was just a little easier. All my data was in the same place and it was much easier to set down my criteria, just because it was all there in the specifications of the instruments.

Connie openly admits that, given the problems experienced with Technical Paper I, she "didn't worry about trying to get something that complicated; that was impressive. I just worried about getting something that I would be able to write a good enough paper to do what they wanted, really." Like Jamie and Angie, Connie received an A on the first submission of her Technical Paper II.

Doug, Jim, and Bernie, the three B writers, all selected "complex" problems to investigate, just as they had for Technical Paper I, which required a significant amount of research. In Technical Paper I, for instance, Bernie further analyzed a problem he had been working on during his summer job in an engineering lab. For Technical Paper II, Bernie's topic was chosen to "figure out how industry would actually go about doing" a particular process he wanted to know more about. He explained that "I had to spend quite a bit of time doing the research, figuring out things for myself simply because it wasn't a topic that was incredibly familiar to me, it was just out of interest."

To write his paper, Bernie relied on research from the library, read magazine articles, borrowed books from friends, and located a key company contact person involved with the process Bernie had chosen to write about. Even with all of his efforts, Bernie's feedback revealed that he needed to improve his wordy writing style, use a point-form listing rather than prose while discussing his criteria and alternatives, and rewrite his introduction to eliminate the detail better suited for a background discussion. Following revisions, Bernie's paper still remained too long and wordy, and sources from

which he had taken his limitations were not always clear. He therefore received an A- for a final evaluation.

Doug Similarly wrote his Technical Paper II based on a topic of great personal interest which he first learned about in another engineering course. He first explains that, in this other course,

> basically they tell you what's so great about a semi-conductor, why we use and need them, and you have to do a project on that. And semi-conductors are what makes solar cells work, and I decided to do a project on solar cells and, of course, as soon as you think of solar cells you think of one of two things - the trivial sort of gimmick, watch or a token calculator or something like that. And the other, the most important and real need for them is in space applications because that's where all electronics in space comes from. Also, I have a pretty deep interest in space and that sort of thing as it is, so that's how I chose that. Also it helped - I was going through an article that talked about different kinds of sensors that you could use on a space solar cell ray and I got some - both things came together and I decided it would make a good topic for a tech paper.

Within his paper, Doug, like Bernie, then conducted a discussion and analysis that was considerably more complex than that of the A writers. During his discussion of the criteria for selection, for example, Doug took one of his essential criteria, changed its limitations, and then used it as a desirable criterion. When asked if he thought this would be acceptable to Professor Branch, he stated,

> We'll find out. I thought about it and it didn't seem to be - I couldn't see why it would be unreasonable to do it that way. I think the most important thing of all this stuff is, well, I don't think they get mad about that.... For example, I've said it once in the essential criteria and then I say O.K., if it makes it past this part of the essential criteria, now I change the limit on that piece and say it's desirable if it makes the same criterion on a different limit. I don't think they mind that if you apply it fairly to every device and don't change things further on, once making your decision.

When he revised his paper, Doug attempted to address concerns raised by Professor Branch such as rewriting his criteria in point form rather than prose style. He continued, however, to have problems with not stating his assumptions earlier in the

paper, and limits on some criteria required a more thorough explanation. His final text received only a B+ in spite of his efforts to achieve an A.

It is also evident from the interview transcripts that these writers took care to develop a solid, sound, and well-written document that would meet the requirements of the instructor. Jim, for instance, listened to both instructors explain how to check for accuracy and thoroughness in the report by reading his paper in three different ways: the abstract; the introduction, conclusion, and recommendations; and the entire paper. The teachers explained that, ideally, a reader should be able to read a technical report on any one of these three levels and, although the amount of detail would differ, the reader would still know what the document was all about. Jim, Doug, and Bernie, took issues such as this seriously in their writing as evidenced in Jim's explanation that his paper

> can be read on several different levels. It can be read through quickly. The abstract can be read, the abstract, and then the conclusion, and that would be enough. But it also could read abstract, introduction, just the conclusion, and that would be enough. So you can only read certain parts and everything would still make sense.

Even with all of Jim's care and attention to detail he still had revisions to complete before earning an A on his final submission. Similarly, Doug gave considerable thought to the way he organized and presented his discussion of alternative devices for selection. He felt it was essential to treat each device fairly so "I list all eight pieces of information for each thing." Doug then explains how he uses two paragraphs to discuss each alternative:

> so the first paragraph - maybe two sentences, three sentences - how the device works, very straight forward. The second paragraph I set out what my criteria were, so what I do is, knowing what qualities I'm going to judge the devices on, I list their performance in each of those criteria, I list what those specific qualities are. For example, if I'm going to pick a device on say, sensitivity, accuracy, and drift, I list for each device sensitivity, accuracy, drift.

In addition to the care and interest taken with content, these three B writers also recognized just how important it was to meet format requirements for a successful paper. Jim explained that "you can't really fool around with the format too much" and emphasized the importance of conforming "to the recipe that they want." Bernie similarly noted that a well-written report without the proper format would not be evaluated as highly as a "not terribly well written paper that follows the format."

These three writers seemed unwilling to opt for an "easy" topic to write about just to satisfy course requirements. Their preference appeared to be one of investigating issues of personal interest in order to learn more about a specific subject. Moreover, their comments express a desire to refine their technical report writing ability as well as to understand better the nature and components of the document. For example, Doug explained that, in the past, "nobody really cared about" his method of compiling a reference list "so I just listed it and did it in a haphazard fashion." For the technical report, however, Doug reasons that

> it actually occurred to me that this is actually a bit more...professionalism was demanded from this paper, I think, and people in industry like to see nice things, so what I did was look up in the dictionary how to write my references.

The three A writers claimed that topic difficulty was not a factor in evaluation so they avoided writing anything complicated or impressive. Angie claimed that the degree of topic difficulty was not a factor in evaluation, and even Aaron, who failed his first draft, maintained that "if it's a pump selection or it's a light bulb selection, you get the same mark as long as you're following with their format." As Connie notes, "The thing I was mostly concerned about was getting it in the proper format and trying to say the things that he would like to hear."

Professor Branch admits that considering the level of topic complexity in an evaluation is a difficult element to assess. He realizes that some writers take chances and challenge themselves by writing about a complex topic while others "fling it just to pass with a good mark." Professor Branch recognized, for example, that Jim wrote a "very complex" paper and that he "could have had an A on simpler things." Similarly, Angie, wrote a much simpler, shorter paper that earned her an A on her first submission. Overall, the B writers wrote a longer, more detailed and complex paper than the A writers.

The A writers ensured, however, that they treated their content in a technical enough manner to satisfy the technical requirements of the assignment. However, as Connie observed, "it's all based on data, but it doesn't matter if you change numbers to make what you're trying to say look better, it doesn't make any difference." These writers recognized that data must appear in a technically correct format and make sense, yet the accuracy of the data was not a factor in their evaluation since form is the most heavily weighted of the two criteria.

CONCLUSION

All but one writer in both groups recognized the importance of following the correct form for writing their reports, and students understood that structure was the strongest criterion against which their technical paper would be evaluated. Where writers differed at the Technical Paper I level, however, was the degree of technical treatment given to their topics. Many Technical Paper I writers emphasized format over the technical treatment of their data to the extent that extensive report revisions were

necessary. This, in part, is because initially unsuccessful writers used a familiar worksite to identify and situate their technical problem. Writers were then constrained by knowing their solution in advance since all data used in the report needed to complement this predetermined conclusion.

Conversely, those who received a B on their first submission understood that content required an intelligent and non-superficial treatment/discussion of their data in conjunction with adhering to the required format. To some extent, they similarly knew how to change and manipulate data so it conformed to the specifications outlined in their document - a lesson Sam learned from his conference with Professor Dickson when instructed to estimate limitations if real data were unavailable. These writers were therefore generally able to balance form and content requirements since their documents required relatively minor revisions.

All but one of the Technical Paper II writers had an even more refined understanding of the relationship between form and content. While Aaron over-emphasized form, the eight other writers provided a reasonably technical discussion within the required organization. It is evident, however, that the writers who "shopped around" in the literature until they found a simple topic to fit the form met with greater success than writers with topics based on personal interest. Each of the A writers relied primarily on one research text to provide the information needed to write a short, succinct technical report. The others who collected data from a variety of texts and company contacts were criticized primarily for minor weaknesses in length, clarity of data, writing style, and presentation.

From a theoretical perspective, it was discussed extensively in Chapter Two that learning the discourse and writing conventions of a discourse community are highly

dependent upon social context. The environment wherein writing occurs generates various purposes for composing and further imposes constraints on the types of texts produced. The genres that emerge within communities become stabilized in form and content because of a repeated purpose for writing as directed by a socially determined group. Together, a socially driven and repeated purpose for writing, and consistency of response in textual features, produce the genres relevant to a given discourse community.

Within Chemical Engineering, the technical report is, as the instructors indicate, one of the most frequently written texts an engineer working in industry must produce. The professors also admit there are many report versions engineers may have to write, depending on individual writing situations, that vary from texts as brief as a single page to those that are much longer and far more complex. Students are taught just one report structure in the Technical Report writing course in an attempt to prepare them for this particular writing demand once they enter the workforce.

Within the university context of the Technical Writing courses, the teachers have determined a generic technical report structure for students to learn. The amount of emphasis placed on learning that format, however, effectively reduces learning to mastering textual features with lesser emphasis placed on understanding relevant contexts for such writing, or knowing the purposes wherein such texts are used in authentic work situations. As well, there is minimal consideration given to content since the knowledge students are expected to produce in their reports is treated almost separately from form. It cannot be said that content is separated entirely from content since writers are advised of what type of topic to select, guided in terms of what subject size or scope best fits both course and format requirements, and directed in terms of where topics are best obtained.

"Teaching" a genre based on textual features effectively reverts an understanding of genre to the traditional classification system of identifying texts purely by structural characteristics. It further strongly isolates form from content since students must, regardless of topic, adapt their information to the required form. The writing exercise, in effect, equates the form to a container into which words, almost regardless of their message, are poured. Given that writing style elements like length, persuasiveness, grammar, and sentence structure are also emphasized, content is further diminished and the "packaging" of ideas highlighted.

The theoretical underpinnings of the teaching approach used in the Technical Writing courses generally opposes current assumptions about the interrelatedness of a community's knowledge and discourse, and further that that knowledge and discourse are communicated through channels approved by the group. In addition, the socially driven purpose for which students write their reports becomes concentrated on the need to complete an assignment as requested by the instructors. This means that the more natural purpose for writing a technical paper in terms of its purpose and function in the workplace has not been recreated in the classroom. It has been explained to them in both the seminar and handout, but the contextual purpose has not been enacted in the classroom. Although the instructors intend to teach students how to write for the workplace, they in fact undermine their own objective and revert student learning to writing to the form.

Since the instructors "teach" to the format, this, in turn, causes students to write to the required text structure. Since mastering form is the agenda of the instructors, then students effectively write to satisfy teacher-expectations. The degree to which students recognized the expectations of their teachers, and wrote with the teacher-as-reader in

mind, determined writing success. This assertion is discussed extensively in the following section. Based on an analysis of both interview transcripts for each writer, it is clear that even though students were encouraged to imagine a busy boss as their reader, successful writers actually wrote to teacher-expectations; thus, they wrote to and for the teacher.

INTENDED READERS

It was discussed in some detail in Chapter Two that knowing a reader's background knowledge and interpretive strategies plays an important role for writers when developing a written text. In keeping with that research, the Technical Report professors give considerable attention to developing a strong sense of reader awareness among their students. During the seminar, comments pertaining to the organization, structure, content, and evaluation of the technical report are repeatedly referenced in relation to what "readers need to know," that certain information "will allow readers to know," or that it is "of paramount importance to define, clearly, to the reader" various aspects of the topic. Professor Dickson explains to students that the very purpose for writing such a report is

> that you're able to take your paper, the contents of your paper, and stand up and say, I want you, Mr. President, to sign the cheque for this because this is why we need it, this is how we arrived at the solution, and I want you to be convinced so you can sign the cheque at the end of this meeting....And that's the whole point of this, is to convince someone that your idea is the best, and the only way to do that is to show them.

Professor Branch also explains that the format to be followed is purposely designed to accommodate the busy reader: "Don't forget, you're dealing with people who receive papers that thick (demonstrates sense of largeness with hand) everyday. They

don't have time to fool around and read a lot of words, so it has to be clear, very well explained." Students also learn that each table in their report should be placed on a separate page. Tables can then quickly be converted to overheads for presentation during business meetings. Moreover, students are reminded to think of their reader's reaction even in relation to issues such as writing style, grammar, poor language quality, and sentence structure. If, as Professor Branch observes during the seminar, the first page is badly written and bores a reader, then it is unlikely the paper will be read at all.

Students clearly receive a significant number of cues to help position the writing in relation to reader needs and expectations in a workplace context. To organize and present material, the professors suggest that students "pretend you are trying to convince your superior, who is an overworked executive, to act on your recommendations." Students are reminded, however, that their "only real reader will be the professor so [writers] should present the material at a level and in a style which will hold his interest." Students are informed that "both professors are graduate chemical engineers who also hold advanced degrees in Business Administration and who have been employed in industry for over eighteen years" (Handout, p. 5).

During the seminar, Professor Branch elaborates on the knowledge and experience of the two instructors to help students further understand the perspective from which they will read the technical reports. He explains that

> we basically cover a lot of ground, technical issues, because we tend to work in basically all different types of industry going from aeronautics to ah, equipment-based to electronic, so we can cover all kinds of ground so we're also checking obviously for what you're providing as far as background or information or technical issues. And that, of course, a failure there is a major problem.

There is, then, a dual sense of audience that students are urged to accommodate in their writing. In effect, students are encouraged to both *address* and *invoke* (Ede & Lunsford, 1984) a reader at the same time. On the one hand, students are counselled to write for a professor who has significant experience in chemical engineering and who is the true reader of the report. At the same time, however, students are advised that they sh ·ld imagine how an overworked boss would react to their paper and write with this scenario in mind as well. As the following analysis attests, all writers were not able to create an appropriate reader framework for their reports.

PERCEIVED READERS

INTRODUCTION

Writing success is dependent upon two factors. The first is whether writers perceived their reader to be either a boss or the professor. The second depends on how well writers assessed the expectations of their reader and tailored writing to meet those expectations. A predominant assumption writers must make, for example, is the degree of background information readers brought to the report reading. The more writers knew what was expected by Professors Dickson and Branch as their real readers, the more successful the writing task. Thus, students who understood what their professor wanted, and tailored writing to accommodate what "he wants," met with greater writing success. Students who perceived their professor as the real reader, understood his expectations as specified in the seminar and handout, and wrote with these expectations in mind, were most successful in terms of evaluation.

TECHNICAL PAPER I

Students in the Technical Paper I course attempted to reach two types of readers. Three of the nine writers said they wrote for a boss and contextualized the writing within their place of summer employment. The remaining six writers assumed they wrote for the professor whose chemical engineering background helped them identify a general level of topic knowledge for their readers.

Although Margo wrote for the professor, and Carrie and Dean for a boss, they all assumed their reader was someone highly knowledgable about their topic and therefore assumed the person would, as Dean explains,

> know why I was writing this, so I didn't really explain it that well.... I figured the person I was writing this for knew the basic principles of the instrument, and I just explained very briefly each alternative, I didn't go into too much detail.

Dean, like Margo and Carrie, subsequently failed both to provide important contextualizing information (e.g., "computer simulations were run on all devices" - who ran the simulations?) and used far too many subjective statements needing to be quantified (e.g., "low cost maintenance" - how low is low?). During a second interview to examine his report evaluation, Dean tried to align his initial reader perceptions with the revisions specified in the feedback from Professor Dickson:

> I didn't really explain why it was important to measure the pressure. He wants - see I had in my mind I was writing this for my boss. In which case my boss would know why I was writing this, so I didn't really explain it that well, but I guess he wants more.... I mean, I guess I got the wrong idea of what he wanted on it, who it was supposed to be, I don't know, like I (pause) the way (pause) from my experience, this summer's experience, like, my boss was always aware of what had to be done, and ah, and I just figured I didn't have to go through that much detail but I guess he wanted more detail of why.

Even though Dean and Carrie assumed they wrote for a boss, and Margo assumed she wrote for the professor, they all assumed too much of their reader and had to supply more detailed information. The following two excerpts are from Carrie's list of essential criteria, the first quote is from her first submission and the second from her revised draft. The purpose of Carrie's report is to select a computer simulator package to improve operations in a zinc plant so her first criterion considers the ease with which the packages can be used.

> 1. **Ease of use** How user-friendly is the program? Is there a graphical front-end which would reduce the "learning curve" and allow the engineer to quickly start developing the simulation?

In this first instance the constraints for qualifying this criterion are stated vaguely and not given precise measurements. This failure to quantify her criteria presents, according to Professor Dickson on Carrie's comment sheet, "a major stumbling block to what has the potential of being a topnotch paper." She therefore revises her criteria to make them succinct and measurable:

> 1. **Ease of use** Due to the time constraints of the project the simulation package must be easy to learn and use. For this project, the user must be able to acquire a working knowledge of the simulator in less than two weeks. A feature that is desirable is a graphical front-end since it would help reduce the "learning curve" and allow the engineer to quickly start developing the simulation.

As all three of these writers discussed their feedback during a second interview, they all assessed required changes in light of what "he wants," meaning professor Dickson, rather than in relation to initially perceived reader needs and expectations. Their comments indicate that, rather than assuming an objective and imagined reader, the writers saw a need to give Professor Dickson the specific information he requested. As Margo observed about her own paper, "there's so much wrong that it shouldn't be hard

to satisfy him by fixing a lot of those things." All three writers revised their texts according to the specifications outlined by the professor and received an A on their final submission.

Three other writers, Randy, Clarence, and David, were also required to revise their papers in light of the feedback received from Professor Dickson. These three, however, each failed in some way to address significant concerns raised by their teacher and received final marks in the B range. Randy was one writer who had particular difficulty assessing his reader and meeting reader-expectations.

Randy not only imagined his former bosses as the readers of his text, but genuinely wrote his report for the company with whom he had been employed the previous summer. He had already studied manufacturer brochures in an effort to help management deal with a particular process problem, and subsequently used the Technical Report course to investigate the issue further. He provided as much information and detail as he possibly could and even included numerous photocopied equipment brochures. His final report, according to Randy, had to be comprehensive since his readers were in another country and might not be familiar with the material used in Canada and the U.S.

Although Randy approached the task with good intentions, he received an F on his first draft. His text was far too long and contained unnecessary information, brochures in the appendix were not shown as relevant or necessary to his discussion, and the required format had not been followed at all. During his second interview, Randy recalled that "He said it's, you're on the right track now and it is the way we want it to be like" when he showed Professor Dickson the revised draft he had prepared for his student-teacher conference. During his second interview, Randy repeatedly saw the changes to be made

in light of what "he wants" even through he did not always understand why certain changes were required. When asked, for example, if he understood why his binder was not appropriate and why acknowledgements should be placed on a separate page, Randy answered "No, [he didn't understand why] he [the professor] was saying this is the way it has to be."

Clarence similarly realized he assumed his reader, the professor, knew too much about his topic once he had examined his feedback and attended his student-teacher conference. Even, however, with revised assumptions about his reader's knowledge, Clarence still seemed somewhat confused about who he was writing for and how much he or she knew about his subject. Rather than writing for someone with considerable knowledge about his topic, Clarence concluded from his student-teacher conference that

> I should have wrote it to someone who doesn't know anything about this.... I guess it could be you were writing for an ignorant boss. But now it's going to be more writing for the teacher. Well, it's not really to whom I'm going to write it, it's just ah, I'm going to try to rewrite it as he wants it.

Even with his revised reader assessment and deliberate attempt to give the teacher what he wants, Clarence still received only a B+ on his final submission since his superficial corrections failed to address several significant content and structural concerns.

The three remaining students in this study group, Susan, Sam, and Frank, all considered Professor Dickson their reader and shared similar perceptions of the knowledge he brought to his reading of their reports. Susan's description of her reader reflects the kind of analysis expressed by these writers:

> He says you assume that it's someone, I assume like an engineer, not like a Ph. D., you know, but someone who has an idea of industry, a general audience. I think of him [Professor Dickson] specifically and I know he has been in industry for a while.... Someone who, if you mention any topic, they won't know it exactly but they might have a feel for it and you

> give them a few more details and oh ya, they'd know that. Dr. Cameron, (another prof. in the department) he's been in industry for so long, you mention anything and he says oh, ya, he knows - that kind of person.

These writers articulated a detailed reader analysis and expressed a refined understanding of what Professor Dickson knew about their topic. As a result, these three writers had only minor problems with providing sufficient background detail and quantifying subjective statements. They also addressed the majority of other teacher-expectations such as length, a suitable comparative analysis table, proper writing conventions, and so on. In short, they knew the information required, and how it should be presented, in order for their writer intentions to meet reader expectations.

There is an interesting "split" in the way these writers perceived Professor Dickson as their reader. On the one hand, comments frequently suggest that writers overtly direct their writing decisions towards meeting the academic demands of the technical report writing task. Students therefore write to "give the teacher what he wants" since they are evaluated on their academic performance.

The following comment from Frank exemplifies the type of statement made by the three B writers. During a discussion to determine how he knew when to put information into an appendix as opposed to the main body of the paper, Frank first stated that "everything that was directly related to the paper I put in the front. Information not exactly directly related" went into an appendix. He then explained the basis for this decision:

> I have the feeling that if someone with that background read it, would think it excessive. And I read the points that Mr. Dickson corrects our things on, and one of them is too lengthy and repetitive, and I didn't want him to think I was putting too much in there, so I put it in the back just in case he wanted to see it, but I didn't put it in the body of the paper because it might not be needed.

The following comment from Susan also reflects how the reality of the writing as a school-based exercise influenced her writing decisions. The following comment from her first transcript came immediately following introductory comments to explain that the nature of this research was to learn how chemical engineers learn to write technical reports.

> It's very simple, he hands out an overall formula, you know what he wants, and that's what you do, that's it. He tells you explicitly, write this, give an introduction, write that...

It is evident throughout Susan's transcript, as well as the two other successful writers, that providing what the teacher wants governed many writing decisions. Thus, the more refined a perception of their "real" reader, plus how and why a technical report must be written, served to influence success with the writing task.

While writers often based decisions on giving the teacher what he wants, they do not sustain this single, concrete reader focus throughout their writing. Thus, there is an apparent division in reader perceptions for these three writers. At other times in their discussion, these writers also referred to "they" and "he" as readers, however who "they" were or "he" is was not evident. The following is an example of the way in which these writers moved away from writing just for the professor to consider some other imagined reader. Sam begins by explaining how he knows when to place explanatory information in an appendix as opposed to integrating it into the body of his paper, then concludes by stating that

> Um, my understanding was the appendix is something that, in case they don't know where I'm coming from, they can go there and read it but they don't have to. So let's say that the professor reading this knows about the sulphur process, this would be redundant to him if I put it in the body of my report.... if I was writing this for an employer, it would be the same thing. Whoever was reading it, if I thought he would know about the process, I wouldn't put it in the body of my paper, I may put it in the

> appendix depending, in case someone else reads it who doesn't know about the process, they have something to look at.

Analysis of the first interview transcripts for all writers indicates that these three writers based their writing decisions on what the professor wanted as a teacher-reader more than any of the other students. Overall, then, it seems that successful writers often recognize the teacher as their real reader and write to meet his expectations. Regardless of all suggestions about imagining a busy boss in a real work context as a supposed reader, the writers who do well in this course generally possess a focused sense of the teacher-as-reader, with set expectations for a successful technical report, and write to satisfy or "give" professor Dickson what he wants.

TECHNICAL PAPER II

Based on an analysis of the first interview transcripts for all Technical Paper II writers, some of these students have learned that success depends specifically on writing to meet teacher expectations. The three students to receive an A on their first submission repeatedly based their writing decisions on giving Professor Branch what he expected and rarely considered an abstract or hypothetical reader. Even Jamie, who said that he had written his paper for a work context and "definitely not" for the teacher, consistently referred to what the course instructors expected from him in his interviews. He noted, for example, that

> This is exactly what they gave me. This is in their outline. This is everything in sections that they wanted to see, so I just gave it to them, and then they wanted to have lots of figures and tables so I just gave it to them.

Although he says he did not write for his teacher, Jamie rarely based his writing decisions on composing for a perceived "other" reader. Near the end of his interview Jamie even stated that he didn't particularly agree with the required format for the technical report, however he conceded that "that's what they want so that's I give them."

Connie also had her instructor clearly in mind while writing her paper. Unlike Jamie, however, Connie was well aware of her decision to write for the professor. It was clear in her mind that she wrote to meet the reader-expectations of the person assessing the report even though she recognized the directive from her instructor to write for someone in a work context. While discussing her perceived reader, Connie explained that

> I sort of really just wrote it for the professor. I know they say you're supposed to be writing it for somebody, say your boss, whatever, but I found it hard to think of it in that context. The thing I was mostly concerned about was getting it in the proper format trying to say the things that he would like to hear.

Angie, another A writer, quickly learned how to "play" the technical report writing game by discovering that "you kind of look at the information available and then you write your question." Rather than establishing a problem to investigate and then conducting her research, Angie first relied on a literature search to create a summary table of her results:

> I started with my table, I wrote a list of criteria, and I got the information for this criteria on my table, so if there was a criteria, say I couldn't really find information, I would take it out immediately, so I just worked from that table. And once you have everything in front of you, you have all your data, it's so easy to pick your final solution.

Once she was confident she had located a problem that would easily adapt to the overall form based on its ability to fit her table, Angie then worked from her table to compose

the various components of her report. This proved to be a highly effective approach to the writing for Angie, so much so that

> if I would tell someone now, I would say do your question or your introduction last. Like, that's what you have to do. You have to think of your problem and get a general idea of your problem, get your solutions, your alternatives, see how much info you have on each, and work backwards from that, you know.

Angie was most concerned with finding a suitable problem for the required form since she understood just how significant structure was to her writing success. She was determined to satisfy all expectations of her instructor and tried to analyze her real reader carefully. This writer, like Jamie, rarely mentioned writing for a reader other than the person responsible for her evaluation. At one point in her interview she explained that she had written a background section for her paper, but

> then I thought that maybe I was explaining something that he already knew so I was afraid of having him say it's not relevant to me, I understand what you're looking for.... I took it out.

These writers who so clearly focused on writing to meet teacher-as-reader expectations were the only first submission A papers in this group. Doug and Bernie received a B on their initial draft and said that although they should ideally orient their writing towards a boss, they really wrote for the teacher since the actual writing request came from Professor Branch. From the analysis of their first transcripts, these two writers really attempted to compose for two readers - a boss and the professor. The following excerpt from Bernie's first transcript reflects how these two writers tried to balance a sense of writing for the teacher in conjunction with writing for an authentic workplace reader. At this point in his discussion Bernie explained why he included a background section in his paper rather than putting additional information in an appendix.

> I guess in the overall sense if I'd been writing for my boss they probably would know about the brewing industry 'cause otherwise they wouldn't be involved in it. But for Professor Branch I figured I might as well put it in the paper because he'll be the only reader, as far as I know, of the paper, so, I guess it was mainly for him.... I would assume including the background within the report is making sure that the actual reader of the report, as opposed to pretending it's your boss, will get an understanding of the background. If this was for my boss, there'd probably be no need for this to be here at all. And, in fact, a background would probably not be needed in the first place, there'd be no need, he or she would probably know as much as I did, or more.

A third B writer, Jim, had a far more complex perception of his readers and genuinely wrote to meet his imagined readers' needs. In Jim's first transcript, he makes few references to giving the teacher what he wants, yet frequently bases writing decisions according to what is best for his readers:

> so the reader knows exactly what these things are going to be used for, not exactly, but he'll know where they're going and what kind of system it's going to so he can get a picture in his mind.

Although Jim uses the singular "reader" at this point in his discussion, he has really written so two readers, with different degrees of background knowledge, can understand his report. Jim met with success since he clearly understood his readers. He explains that his reader perceptions are based on discussions with his father, also an engineer, who has experience reading reports as both a project supervisor and manager:

> Um, I got it from ah, actually from my father. He reads a lot of, well, he comes across a lot papers like this, and ah, from papers that I've written before, I would have him look over them and he would say sure, if only a chemical engineer, a supervisor's reading this, it would be fine, but if I was the management person, I wouldn't know what you're saying, or what you're trying to get across. So, you say write it for the technical or the person who knows everything that's been going on, and also for someone who might be involved with it, say you wanted to purchase something, and the person who's going to purchase it may not have the engineering background, and even though they might not read it from start to finish, the parts that they will want to read, they should be able to understand without great difficulty.

Jim's paper, according to Professor Branch, was excellent in terms of his topic and the way he had treated the problem, however there were a few specific points requiring attention before the paper warranted the A it received on the final submission. Aaron, on the other hand, was not able to deal with his writing problems as easily as Jim. Aaron was the only writer to receive a D on his first submission and revise his paper just well enough for a final B grade. According to his transcript, Aaron bases few writing decisions according to the needs of any reader, be that reader imaginary or real.

Aaron in fact hesitates and requires time to think when asked about his intended reader: "I assumed it was ah, (pause) I guess I assumed it was someone who knew about the topic almost or as much as I did." His phrase "I guess" is frequently found throughout his discussion. For example, in the following excerpts, Aaron first explains that his background section is integrated into the main body of his paper "so it's not just coming out of the blue and the reader has a better idea of what he's reading." When questioned if it was for the benefit of his reader that he had chosen to incorporate the information, rather than attach it to the back in an appendix, Aaron answers that

> Ya, I guess so, because it was fairly important, I guess this assumes the reader doesn't know too much, or as much as I do, but I was writing it, so I guess, when he was reading through and reading about the criteria it was I guess important that he had a general idea of why I wanted a certain thing.

As a final note, it should be clear that teacher expectations include a multitude of writing elements from ensuring topic originality, providing sufficient contextualizing information and quantifying subjective statements, and following the proper format, to providing a clear, easy-to-read writing style that avoids rehash, irrelevance, and generalization. Students therefore have a significant number of factors to consider while

writing, and a major flaw in any one area can negatively impact upon assessment. Aaron's assumption, for example, that

> if you have the right format and it's just a matter of, if it's a pump selection or it's a light bulb selection, you get the same mark as long as you're following with their format

is limited in scope and therefore causes him to neglect other elements of his paper. Similarly, Bernie writes a strong paper, yet he continues in his second submission to be somewhat verbose, redundant, include long sentences, and submit a paper that is too long overall. As a result, he is unable to achieve an A for a final grade.

CONCLUSION

There are two key dimensions of the reader issue that are significant to the success of writers in both Technical Report writing courses. On the one hand, writers imagined or assumed they wrote for either a boss or their professor. From the course handout and seminar, students understood that the instructors wanted them to imagine a busy boss and write with this particular individual in mind; however, many writers recognized the professor as their real reader and actually wrote with him in mind. In addition to selecting their readers, students then had to assess the level of background knowledge that these readers brought to their report reading.

Writers met with the greatest success when they wrote for their teacher rather than a boss, and further assumed that the teacher had some degree of familiarity with their topic yet needed additional background information. The more aware students were of their teacher's knowledge and expectations, the greater their success with the technical report writing task. Thus, the more focused writers were on their real reader and his

knowledge, and the less consideration, or interference, they allowed from a supposed or imagined reader, the better their evaluation.

The second report A students rarely mentioned writing for a hypothetical reader and consistently based composing decisions on giving their real reader - the teacher - what he expected. They similarly understood that he had a basic level of understanding about their topic but that additional contextualizing information had to be provided. These writers met with success because of their unwavering focus on their teacher-as-reader and recognized the level of detail at which their papers needed to be written.

The B writers in both Technical Paper writing courses did not maintain this clear perspective of the teacher as their reader. They predominantly assumed they wrote for their teacher, however they did not remain focused on this single reader since they also referred to another, more abstract hypothetical reader. There was thus an evident split in terms of reader perceptions among these writers. In addition to this dual sense of readership, these B writers also erred in terms of the assumptions made about their reader's level of familiarity with their topic. This was also true for those writers who failed their first submission in both courses. These students tailored their writing to meet the needs of a reader whom they typically assumed knew a considerable amount about their topic. Once those who received a grade below A revised their reader perceptions, and changed their paper to satisfy the demands of the teacher, students received a higher final submission evaluation.

It was discussed in the first section of this chapter that a key reason for teaching students to write a technical report is to prepare them for a common writing task once they enter the workplace. The instructors therefore attempt to create a writing context that reflects an authentic writing situation by directing learners to compose for a busy

boss. Students are told to imagine that their reports will be read by a manager in the chemical engineering industry even though the real readers are the two course instructors.

In spite of this attempt by both instructors to help writers become more familiar with the workplace by asking them to write for a workplace reader, their efforts are unsuccessful since most students, either immediately in their first draft or following teacher feedback, end up writing specifically for the instructor. The course becomes a writing process wherein students must evolve to assess accurately what knowledge their teacher possesses about their subject in order to write with this knowledge in mind. Not only must students identify the teacher's knowledge about their subject, but, in keeping with the earlier discussion of the relationship between form and content, writers must also understand the significance placed on meeting form requirements.

Writers thus compose to meet the expectations of their teachers by recognizing the need to select a topic that adapts well to the structure, following the format required, and supplying a suitable level of contextualizing detail for the professors who are the real report readers. The extent to which the form of the technical report is emphasized results in students writing to the structure, and thereby to meeting teacher-expectations. Students are, then, highly focused on giving the teacher what he wants in terms of detail while similarly attempting to satisfy all form requirements.

The research and theory discussed in Chapter Two suggests that a key element of learning in a discourse community is knowing the knowledge and interpretive strategies of readers. It can be argued that the A writers in the second writing course have learned how to write a technical report for the academic counterpart of their professional chemical engineering discourse community. These students identified their teacher as the true person for whom they wrote, and accurately assessed his interpretive strategies in

terms of satisfying form requirements, providing adequate background detail, quantifying data, writing concisely and persuasively, and ensuring grammatical and structural correctness.

Though the A writers have learned to write a technical report for their academic engineering community, it brings into question whether or not writers have learned to write the same report for the workplace. The following section is based on an analysis of both interview transcripts for each student, and explores the extent to which students see their academic learning as relevant to the technical report writing they perceive will be expected of them once they enter their professional chemical engineering community. This discussion is situated within a broader discussion of overall course objectives since the issue of learning the report for the workplace is related to other objectives such as learning the required format and developing a more succinct writing style.

COURSE PURPOSES

INTENDED

Five predominant and concatenate objectives for the Technical Report writing courses can be identified based on discussions with the professors, the course handout, and the writing seminar. One is for students to develop their problem-solving ability and to do so in relation to only one problematic aspect of a particular plant. Rather than designing an entire process or running a series of experiments, the technical writing course requires students to address only one, relatively small function within an engineering process. A second objective is to deal with a problem relevant to a specific workplace context on a commercial level rather than on a long-term research basis. This

then provides a highly practical focus and purpose for a technical report given its immediate relevance to a worksite.

A third objective of both courses is to help students learn the writing conventions, particularly the structure, of a common workplace technical report to communicate an analysis of alternatives. Fourth is to write with conviction, accuracy, and detail well enough to persuade a supposed employer to purchase a recommended solution. Students must therefore learn how to sell an idea rather than simply record or report data. Finally, the fifth objective is to provide a valuable writing experience to prepare students for the writing demands encountered in their eventual workplace.

PERCEIVED

Of the five objectives identified above, the final three - that of learning document writing conventions, particularly form; writing in a succinct, developmental, and persuasive manner; and gaining experience for the workplace - emerged as the learning foci among students. For the most part, students did not isolate these three objectives from one another but regarded all three as relevant to their learning and success in the course. Most students considered learning the format to be their primary objective followed by developing a concise writing style. All of the students, however, recognized the value of learning to write a technical report as preparation for the workplace.

As Doug, a Technical Paper II writer, explained during his first interview, he understood the benefits of learning to write a technical report in university because "this is what you do as an engineer." Jamie, also a level II writer, stated that

> my personal opinion is that they want to ensure that students that leave at least know how to write a proper selection paper. And there can be no two ways about a paper like this. If you're writing a paper for a company on the selection of something there's just a way that it has to be done, and they want to make sure the minimum is there so that everyone can do that.

Margo, a Technical Paper I writer, noted that the purpose for writing a technical report was to provide practice in writing a paper for the job market. She indicated during her first interview, however, that the basis for providing this practice was to change the way students write.

> It was more for changing our writing from writing labs for professors to writing technical reports for the business world. It was to give us practice in that.

During a second interview, Margo elaborated her sense of purpose to explain what she meant by the need to change her writing. From her comments, it is evident she considers learning a new format as the element for change.

> Most of the papers we write here are structured in the lab format, but when we're working as engineers, they won't be structured like that at all. They should be more suggesting to use this piece of equipment which is exactly what the tech paper is, it's looking at a bunch of different kinds of something and choosing the right one, and that's more what we'll be writing rather than just lab reports...it's a very different format.

Margo's comment reflects the perceptions held by most of the writers in that learning the required structural format was the primary objective of the courses even though they recognized the value and relevance of the learning in relation to their eventual work. Students predominantly understood that learning the imposed format was most significant. According to Connie, a level II writer,

> it doesn't matter what's in it, all that matters is how you present it. It's all format, you just stick the words in.... It does, up to some extent, sort of matter what you tell them, but it really seems to be how you present it. That's the biggest thing that they're looking for.

Connie's assumption about the significance of the format is based on her experience with writing Technical Paper I. She maintains that the reason she received an F on her first submission during the first course was because she had not talked with enough people, nor looked at enough papers from former students, to "see exactly how I was supposed to present things." To revise this paper, Connie explains that "I really didn't change anything in it. All that changed was how I presented my data." Her resubmission for this first report received a B+. Connie learned from her Technical Paper I report writing experience since, for Technical Paper II, she scanned the literature for a topic that conformed easily to the required format and concentrated on ensuring she complied with all format requirements. She subsequently received an A on her first submission for her efforts.

Although Connie, like others, stated that her chief concern was following the format, she did concede, in the above statement, that "it does, up to some extent, sort of matter what you tell them." Her comment reflects the thinking of most of the writers in that consideration had to be given to what the report actually said, and how it was stated, even though organization was their predominant concern. Students periodically referred to the need for their writing to be "succinct," "concise," "technical," "logical," and "not flowery." Writers were thus concerned about factors like writing style and developing a convincing argument even though they did not place as much priority on such elements as they did for meeting form.

Angie, a level II writer, for instance, stated that format was her main concern for writing a successful report. She elaborated this initial statement, however, to include her writing style and the need to show her "thinking process" to the professor as her paper developed.

> I don't find there's as much focus on writing as there is on ways of thinking where you have to come out with the solution.... It's not so much paying attention to what your sentence structure is like, which they do look at but I mean the sentences are very easy, this pump works like this, this does this, you don't have to elaborate your sentences very much so it's very simple writing. Basically, what's harder is just finding your topic, going through the thinking process of what you're going to pick, why you're going to pick it, the reasons, and then just, the set up more than anything else. Cause you want him to see that you've thought clearly so your thinking process has to come out.

Most students and the two teachers share the same goals of mastering the Technical Report format, not only for immediate academic success, but for the long-term benefits of such learning in the workplace. According to Jim, a level II writer, "most engineers graduating had no idea what to do and were handing in garbage to their superiors," so he, like others, recognized that learning to write a proper technical report would benefit students once they finally entered the workforce. Moreover, students understood the need to be technical, succinct, explanatory, and persuasive in their writing even though such factors were not expressed as a primary concern.

There are two writers, however, who do not share the same "set" of writing goals as those of the writers just discussed. Aaron, a Technical Paper II writer, has a restricted sense of purpose in that the course is "to teach us some sort of standardized approach" for organizing and writing a technical report. In other words, although Aaron indicated in his interviews that what he learned from the course would benefit him in the long-term, he was most concerned with delivering the correct document structure. Following the format posed no problem for Aaron since he received a high rating for this criterion on both first submissions of Technical Papers I and II. In spite of this, however, Aaron received a D on his first draft in both Technical Paper writing courses.

From a study of his evaluation reports, Aaron experienced numerous problems with his writing even though format was not a hindrance. The weaknesses in Aaron's writing were not, however, consistent between both tchnical reports. For instance, the introduction in Technical Paper I received a high rating while his Technical Paper II introduction was considered poor. These kinds of disparate problems are repeatedly evident in the evaluation reports for both papers. Final evaluations were also inconsistent in that Aaron moved from a D to an A- for Technical Paper I, and from D to a B for Technical Paper II - the lowest final grade for all Technical Paper II writers in this study.

This writer possesses a too narrowly defined sense of purpose for the Technical Paper writing courses. He assumes that following the assigned format is all that is required to meet with success and similarly treats the assignment as an academic exercise with little relevance to his eventual workplace. Unlike other writers, Aaron does not have the additional understanding that he must select and develop a topic that conforms well to the imposed structure; nor does he recognize that data must be quantified and the report presented in a succinct, grammatically correct manner. Even with the opportunity to correct his assumptions based on writing Technical Paper I, Aaron's perceptions of purpose go unchanged in his second writing course. A second writer who did not share the same comprehensive sense of purpose is Randy, a level I writer. Although he expressed a sophisticated understanding of purpose, and generally matched the intended objectives established by the professors, he lacked the one factor in his discussion that is of paramount importance for success in the course - that of mastering the required form.

> Usually, as I know, engineers are problem-solvers, as a general definition about engineers, and they solve problems on an industrial scale, and on an industrial scale you work in a business group so you don't have to write equations in class, you have to write reports, it's technical reports, but you have to have good writing skills to impress, to influence the reader, which

> is your boss, maybe, and not to take it from only a technical point of view but from the feasibility of the project. And ah, be practical, and discuss a certain problem in industrial, in practical industrial processes, and to have the ability to write in an engineering way and to impress the reader.

Randy's paper subsequently failed, even remotely, to follow the imposed structural outline. Professor Dickson even noted that Randy neglected to submit his paper in the black accopress binder (type 2507) asked for in the course handout (p. 6). This lack of compliance with the prescribed format ultimately created problems throughout the entire document, thereby resulting in an F grade for his first submission. He revised his text to earn a B on his final submission, however Randy's B grade was, like Aaron in the second course, the lowest final evaluation for all level I writers.

CONCLUSION

Among writers in both classes, Aaron and Randy are the two writers who do not have a balanced sense of purpose in terms of course objectives. Aaron's situation is unique in that he seems to understand a basic purpose for the course - that of learning the format for writing a technical report. He has, however, yet to grasp the need to conduct a succinct, well developed critical analysis of alternatives from which an appropriate solution is recommended. Because Aaron does not recognize course objectives other than form, he fails to consider other important factors in his writing such as style, substantiating assumptions, and quantifying data, and therefore scores lower on his paper than the other level two writers.

Similarly, Randy became so concerned with writing a descriptive paper to impress a boss in the workplace that he neglected to recognize mastering form as one highly important course objective. Writing for the workplace so dominated his personal

objective that he missed dealing with his writing style appropriately and adapting his ideas to the requisite format. The remaining writers in both courses, however, had a balanced sense of purpose for their writing and learned, even if revisions were required, the stylistic and structural conventions for writing a persuasive paper. These texts, writers believed, would provide them with an acceptable model for their future technical report writing experiences.

The technical report model that students have been provided, however, represents only one of many types of technical reports that engineers write in industry. This sentiment is expressed by Frank, a Technical Paper I writer, who recognizes that the report he has been asked to write is just one of many probable ways to organize this particular type of document.

> I guess this is acceptable, but maybe the employer wouldn't like this form and would like another type of form, so I would always like to see another type of form....I think this is a general format...but I'm saying there might possibly be variations on the format that maybe an employer might want....My general experience is that you always mould the paper to suit with your employer, or teacher, or professor, or whatever.

He further recognizes that there is a need to adapt the way various texts are written to meet the expectations of his readers. Frank, like so many of the writers, adapted his writing to meet the expectations of his teacher, particularly in the area of satisfying structural obligations.

The research and theoretical discussion in Chapter Two focuses on the way in which the learning of a professional discourse community requires an immersion in that culture to learn a group's many uses and constructs of knowledge, discourse, genres, conventions and interpretive strategies. It requires an ongoing engagement with communal ideas through reading, writing, and speaking a community's texts in order to

understand the many ways that members use, express, and package those ideas for a variety of purposes. Writers select appropriate content and conventions according to individual writing purposes and needs. Ideas, conventions, genres, discourse - these and other elements of a community are not treated in isolation from one another but selected from a dynamic and encompassing myriad of uses guided by purpose generated within the social context.

The technical writing courses, however, tend to isolate the technical reports in two distinct ways. In one instance the report model taught to students is separate from other types of technical reports. In Frank's statement above, he assumes there are other ways to write this type of document depending on the differing expectations of various readers. The professors state in the handout that this is true, that there is more than one way to write a technical report, but these other formats and purposes for writing are not discussed in the context of the two Technical Report writing classes. Thus, while students may agree that they have learned a useful model and feel better prepared for writing in the workplace, they have learned only one hypothetical purpose for writing, and only one way of responding. This structure is therefore isolated from other purposes and formats.

The technical writing courses also tend to isolate the genre, discourse, and writing conventions from other texts within the community. Rather than positioning the writing within the wider community context and drawing similarities between the technical report and other texts of the discipline, the technical paper is perceived as something different from all other documents largely because it requires a different format. Students are told that the technical report is neither a lab report nor a design process report. They are told, in effect, that they have never written anything like the technical report before.

To make the report even more distinct from other texts in the discipline, students are advised that the topic chosen for the technical paper should not be related to any other courses taken in their degree program. In the following section, this issue is examined more closely and the extent to which writers see a relationship between the texts they write in their academic discourse community is discussed.

JUGGLING CONSTRAINTS AND SITUATING TEXTS

As mentioned at the beginning of this chapter, the three courses, Design, Lab, and Technical Report, constitute a language-using and learning environment where writing plays a significant role in teaching novices their discourse community. This, in effect, comprises a major part of the context for learning the conventions of Chemical Engineering discourse since novices develop their ability to use, in writing, the language and ideas that have currency within the group.

Project Lab solves a chemical engineering problem in which students are required to analyze a situation to determine what experiments are needed for a resolution. Students then perform these lab experiments and submit their procedures, findings, and recommendations in an extensive descriptive report written collectively by study group members. Project Design similarly requires students to analyze and solve a problem. This task, however, requires extensive calculations for writers to design a complete engineering process. This course also requires students to submit their problem analysis, procedures, and findings in a detailed document written by all group members.

The courses share a central learning focus and writing purpose in that they are all problem-solving in nature even though each deals with a separate aspect of the chemical

engineering industry. It is logical that the learning in all three courses would concentrate on solving problems in industry since, as discussed in chapter three, engineers are problem-solvers. Since this is the central focus of engineers, then it is not surprising that the university structures its learning around teaching how to think and "be" as engineers.

While interviewing students, one orientation taken during those discussions was to determine whether or not they recognized any similarities between the three courses in which writing played a significant role. The purpose for encouraging this direction in the discussion was to see if students recognized the problem-solving purpose and function of their learning since this is the primary task of a chemical engineer. All of the students were in a position to address this issue since they had all completed both Project Labs I and II, dealing with experimental problem-solving, before their Technical Report course. Similarly, most writers had also completed their major Design Project in which they had developed an engineering plant process for a client outside of the university. Those who had not written their major Design project report were enrolled in both Design and the Technical Report writing courses during the same semester. Even though some students had not actually written their plant process report, they were highly familiar with the nature, purpose, and format of the document based on frequent discussions about the report among students within the department. Design Project is a popular course since students work with an external client to solve a specific process problem. Since working with a client gives the report an authentic purpose and reflects a task demanded in the workplace, it generates substantial interest and discussion among students.

Both interview transcripts for each student were studied to determine whether or not writers recognized the similarity in purpose and function for the three major writing documents of their degree program. Only three of the students among the sixteen writers

in this study recognized the problem-solving similarity among the Lab, Design, and Technical Paper reports. These three writers most closely associated their technical report with the design project since they both dealt with solving a process problem as opposed to the chemical and experimental nature of the Lab course.

For Dean, a Technical Paper I writer, these reports are similar because they are both geared for submission to an engineering colleague to outline "why or how to build or select something." According to Dean, the technical report must show an engineer's problem-solving steps leading to a conclusion. Bernie, a level II writer, also recognized the problem-solving function of the technical report and understood that it shared the same function as other texts he had written during his program. Moreover, Bernie also noted format similarities between the different documents, however he stated that the technical report required a far more rigid structure in comparison with his other papers:

> A lot of components are similar. Reports have to have an abstract, problem statement - we're usually given a problem and have to be able to solve it, so a lot of the things are similar to this format. Except, in most courses, besides this one, we're given a lot more play. If it's a particular topic, you don't have to follow an exact format, but the general format is about the same. There'll be the intro, the problem statement, the discussion of the problem, the results, and then the conclusion, and that's about it.

For Angie, another level II writer, the technical report is like her design project except design is "taken much bigger 'cause there you're actually solving the problem, and then you explain what you did." Angie's perception is that because the problem to be solved is a real problem for an authentic client, then the report must contain considerable description and calculations detailing how the solution was obtained. Given the need for such detailed description, a design report is quite long. Conversely, a technical report is restricted to conducting an analysis of device alternatives and is therefore much shorter.

Carrie, a level I writer, also expressed a familiarity with the technical report format, however she compared her school assignment to a report she had written for a summer employer rather than with the other academic writing tasks of Lab and Design. During her discussion she explained that the "base structure" was the same between the two reports so the report she wrote for work gave her valuable writing experience before composing her technical paper. The writing she had done for work was particularly beneficial since she used the topic from this report to write her school report. The difference, Carrie noted, is that the technical paper was so defined in structure that she had to "regurgitate the research in their format."

Most students, however, stated emphatically that they had not seen or written such a report in the past. The following comment from Doug, a Technical Paper II student, reflects the sentiment shared by most of the writers:

> Nope this is a new kind of writing for me....
> As a matter of fact, this is quite a bit different than any other type of paper I've ever had to write before.

For students, the need to follow such strict guidelines for form and presentation distinguished the technical report from any other documents written. They not only found following the organization a new feature, but writers also emphasized a lack of familiarity with the format itself. These writers were unable to position technical paper writing within the broader general framework of problem-solving report writing in engineering.

Most writers could not see a connection between the technical report and other documents because of the focus placed on following the imposed format of the technical writing course. Students were thus generally unable to describe the collective writing of their profession as problem-solving in scope and nature. Most writers were unable to

recognize the shared problem-solving function of the major texts they produced in their degree program. They could not, in effect, move progressively from "part to whole" in the sense that the technical report did not fit within a broader conceptualization of function for the writing demanded in engineering.

CONCLUSION

Overall, writers seemed constrained by the rigid format requirement of the technical report since all but three students were unable to conceptualize the shared problem-solving function of the writing tasks. The need to follow such a detailed and specific structure meant that nearly all writers actually perceived the technical report as something unfamiliar and unlike anything they had ever written. The Lab and Design courses encourage students to think like engineers as problem-solvers by integrating the learning of knowledge with using the community's discourse. Students learn to solve an unfamiliar process problem, thereby expanding their knowledge of their community. They then deal with this knowledge through writing memos, delivering oral presentations, and documenting research and conclusions in a final report. This course format thus represents an immersion in the community's knowledge, discourse, ways of communicating, and also its ways of being since students conduct themselves as engineers working with a client.

Conversely, the Technical Report courses have only one dimension as its focus - learning "the" technical report format. Since the instructors distilled a generic format of the report, they are, in effect, attempting to teach writers the technical report genre. But this reverts to the former, traditional notion of genre as determined strictly by the

reiteration of textual features without considering any repetition in social context or purpose as well. The writing itself thus becomes isolated from socially motivated and repeated purposes, as well as other texts, writing purposes, and writing conventions within the community. This separation is particularly evident in that the final product is just one of many aspects learned and evaluated in the Lab and Design courses. The reports from both courses are not the primary basis for student evaluation since students perform several activities throughout the semester, all of which are considered in their final evaluation. Emphasis is thus placed on the various learning activities rather than predominantly on the final written product alone. In the Technical Writing courses, however, there is only the report to learn, the primary focus of which is getting the correct structure, so it becomes the predominant focus for evaluation.

The concentration on constructing a report in the style and format prescribed makes developing a particular type of writing ability central to the Technical Report courses. Even though students must analyze and solve a problem just as they are similarly expected to do in their Lab and Design courses, knowledge is not considered a focus for learning since students are to learn their report content well enough to present that information in the proper outline. As Professor Branch states, "the course is not designed to see if students are good engineers or not," so the locus for learning is on how well content is adjusted to each of the many report components requested by the instructors.

The final section for analysis focuses more closely on the technical report teaching and learning process. Chapter three provided a detailed discussion of this process for students in the Technical Report writing course. The next data analysis section examines the extent to which the various elements of that process enabled students to master

conventions for technical report writing. The following therefore considers how effective students considered the course handout, seminar, and student-teacher conferences in their learning.

In addition, Technical Paper II writers relied on their first report writing experience to guide their decision-making for the second report. In other words, once students had successfully completed their first writing course, they then used that report as a model for writing their second technical paper. Technical Paper I writers similarly relied extensively on reports from former students to guide their writing. Level I writers examined one, in many cases several, A papers which they borrowed from students who had completed at least one of the Technical Paper courses. As a final influencing factor for the writers in this study, students were also probed to consider the effects of the two data collection interviews on their overall technical report writing development. Students were encouraged to reflect upon the influence on the interviews since discussions concentrated on their writing, a topic they do not ordinarily examine in detail, and because the interviews were not a natural part of their instructional process.

FACTORS INFLUENCING THE WRITING

MODELS

Technical Paper II

From an analysis of the interview transcripts, these writers were strongly influenced by their first technical report writing experience and modelled their second paper from Technical Report I. In addition, all students could recall areas for which they had been criticized on their first technical report and ensured these weaknesses were

addressed in Technical Paper II. According to Angie, an A writer, writing the second paper was much like "working from a previous final product and fixing that" so the second paper improved drastically from the first.

One of the most significant writing elements Technical Paper II students learned from their first report writing experience was to follow the structural organization outlined by the instructors. By their second writing course, students recognized that any variation of the form significantly impacted their mark. Bernie, for example, felt that

> the idea of just selling something sort of bugs me a bit. It gets around the fact that there are advantages and disadvantages [for each device alternative] and there's just weighing out the balances.

By weighing advantages and disadvantages, Bernie maintained that he could arrive at his own conclusion yet allow readers to reach another solution if they chose. Bernie followed his instincts about the way to write a technical report for his first paper and outlined the pros and cons for each device. Not surprisingly, he received an F on his report with the comment from Professor Dickson that "The 'Advantages' - 'Disadvantages' approach is weak, inappropriate and unconvincing, making your decision unconvincing." During Bernie's first interview for his second paper, he reflected on his earlier writing experience and recalled that

> I don't know, maybe I was just being rebellious or something, but I decided that I really didn't want to write a paper like that, and they didn't like that very much at all, so they handed it back, and I decided there's no point in failing a paper just because I'm not writing it the way they want it, so I changed it to what they would have liked.... When I submitted it I understood the idea, but I wasn't sure they were going to be incredibly serious about making you stick to it, when I realized they were very serious then I decided it was a good thing to do.

For his second paper, Bernie was not prepared to take chances with asserting his own ideas about content or organization again and explained that

> After I'd written Technical Paper I for the second time and resubmitted it, realizing the form that they wanted, I just took that form and applied it to a different problem.

Jamie experienced the same difficulty as Bernie with his first paper - discussing the advantages and disadvantages of his device alternatives - which he was certain not to address in his second report. Connie's first paper also needed "a major overhaul" because, as Professor Dickson explained on her comment sheet, she had a "Major flaw in [her] selection criteria. It's essential to put them at the beginning...**all** of them...don't introduce them at the end." Connie understood from this response that the form was the most important factor in writing a technical report.

In addition to structure, Connie, like other writers, also learned to quantify subjective terms and provide more background or contextualizing detail for many of her statements. In her first report Connie failed to qualify statements like "versatile" and "the time for analysis should be relatively quick." She needed to define her "versatility" and "quickness" with concrete, measurable, and non-subjective parameters to ensure all potential readers would share precisely the same meaning. Connie addressed the issue of form and quantified her criteria in measurable terms in her second report well enough to receive an A on first submission. Similarly, Jamie suppressed his desire to provide the advantages and disadvantages for his alternatives and followed the required form well enough to warrant an A.

What is interesting to note about all of the A writers is that because they selected relatively simple topics that neatly conformed to the required format, this allowed them to ensure previous problems were addressed without introducing new errors. Unlike the A

students, however, the three B writers, Bernie, Doug, and Jim, selected topics of genuine interest which therefore introduced new weaknesses into their second report even though errors from their first writing experience were avoided in the second paper. Bernie, for instance, needed to quantify his criteria, avoid using an advantages/disadvantages approach, and strengthen his potential problem analysis in his first report.

For his second paper, however, Bernie was strongly criticized for being too verbose, repetitive, and writing too many lengthy sentences. It is interesting to note that Bernie received a high rating for the style and phraseology criterion on Technical Paper I, yet was criticized extensively in this same category for his second paper. The concerns raised in Technical Paper I were not, however, problematic in his second report. He explains that, for Technical Paper II,

> the only real problem that I came up with was balancing how much I should tell myself and how much I should leave out because I was learning it all at the time anyway. I almost wanted to write into detail just so I know what I'm writing about because, through the writing, I'll get things straight in my head. So it was more of a balance between how much information to include and how much to just streamline it down.

In his written comments, Professor Branch had advised Bernie that he needed to address his verbose writing style before the paper would warrant an A rating. Even with revisions, however, Bernie continued to have problems with wordiness and repetition to the extent that his final submission received only an A-.

The final writer in this group, Aaron, addressed the concerns raised in Technical Paper I when he wrote his second report, however this second paper had a number of problems different from those of the first. While he was able to revise his first paper from a D to an A-, he was only able to correct the D on his second report well enough to receive a B on his final submission. For his revision, Professor Branch noted that Aaron

continued to have minor problems with a poorly developed introduction as well as weaknesses in grammar and writing style.

Technical Paper I

These writers obviously did not have a first report writing experience as a point of reference for composing their second paper, so most students relied on one or more 'A' papers from other students upon which to model their writing. One writer, Randy, was the only student in this group who did not rely on such a model to help with his paper. He subsequently experienced significant problems with his organization, content, and writing style to receive an F on his first submission.

Of the students who did rely on other student papers to model their reports, those who earned a D or an F on their first submission only studied the papers well enough to ensure they knew what format to follow. Carrie, for instance, looked at several old papers to learn the structure and found that the papers were "all basically the same." Conversely, however, those who received a B on their first submission relied on more than just a cursory glance at the format of their models. Frank, for instance, examined three papers, all of which received an A on the first submission, and drew the elements he liked from each report and integrated these into his own paper.

Similarly, Sam not only studied a friend's second submission 'A' paper, but examined the feedback this writer had received on his comment sheet as well. This, according to Sam, was extremely helpful for his own writing. The last B writer, Susan, observed that "I don't know if it's true in other faculties, but in engineering people use the method of example a lot." She explained that this is because first-year students are

assigned a "big brother" to offer support, guidance, and assistance to new students in the department. Susan therefore talked about her paper with her big brother and also used his A paper as a model for her own writing. Susan also explained that she had collected various writing tips for accommodating a busy reader from different professors throughout her studies at Eastern.

COURSE HANDOUT AND SEMINAR

To varying degrees, students in both writing courses relied on either the course handout, the writing seminar, or both to help with their writing. In terms of the seminar, this session clarified the handout for many students which then provided writers with a useful reference document while writing their reports. Some students found the seminar presentation particularly useful for explaining the teachers' overall philosophy of the course. Others determined it enabled them to best identify what was expected in a technical report and how it should be organized. Doug, for example, a Technical Paper II writer, explained that "I feel that's where I really learned what they wanted and what this technical paper was all about." Similarly, a level I student, Dean, specifically appreciated the class critique of a technical report because "it was a good discussion about what should be in a paper."

Not all writers, however, found the seminar helpful, and two students even said they found it "totally useless." One writer, Carrie, a Technical Paper I writer, was unable to attend the seminar because of a work commitment. Those who did not benefit from the seminar relied predominantly on the course handout to guide their writing. Overall, however, writers who benefited from the seminar, in addition to those who did

not, used the course handout as a writing guide. Interestingly, however, most writers did not read the entire handout but referred primarily to the section that identified and explained the various report components (see pp. 107-114 of this chapter or Appendix B). One first level writer studied only the discussion on grades and simply skimmed the remainder of the document. Similarly, a level II writer examined the list of most common mistakes for technical report writing and did not attend to the rest of the text.

Randy, a Technical Paper I writer, used only the course handout to help him write his entire report. He knew he would be away the three weeks prior to submitting his paper, and wanted to ensure he had the assignment completed before leaving, so he wrote his paper and then attended the seminar. Randy explained that, as he listened to the presentation, he realized there were structural and content components that he had either neglected to address or had dealt with differently from the method described by the professors. He adds, however, that he was unwilling to change what he had written because of the time and effort already given to what he thought was a well written report. As Randy observed,

> When you do something that's difficult, like spend a lot of time at it, it's difficult to say it's wrong. I was, like, in that category. Another thing is that, like, he basically said if you let another reader, like, not an engineer, read your paper and understands what you're saying, then you have made a good paper. So this is basically what I had in mind. I went to a reader [a graduate engineering student], he read it, and it made sense.

Randy's paper followed a considerably different format from that expected by his instructor and was also seriously flawed in terms of appropriate content. The report was so problematic, in fact, that it prompted the following response from Professor Dickson on Randy's comment sheet:

> It is clear that you have had some very practical experience, however it is also clear that a) you didn't come to the seminar we gave, b) you didn't

> read the course instructions, c) you didn't understand anything in a) or b), or, worse, d) you can't follow instructions.

From the above, it is evident that students initially have three means by which they learn to write a technical report: successful models of other student writers, the seminar, and the course handout. Technical Paper II writers relied extensively on their own first report as a model and basis for writing their second paper. Students writing their first technical report similarly used models from writers who had already successfully completed their first writing course.

In addition to the models, it appears that writers in both courses rely on at least one other learning method, the handout or seminar, to influence their writing. Even though Carrie, for instance, did not attend the seminar, she relied on the course handout in addition to the models she had selected to help her writing. Although she received a D on her first submission, her problem was largely one of quantifying her data since structural errors were minimal. She subsequently revised her paper to an A grade for her final submission.

Conversely, however, Randy did not use either a model or the seminar to guide his writing. He therefore failed his first submission to the extent that Professor Dickson did not evaluate all of the paper and even questioned Randy's ability to follow instructions - if he had followed them at all. The significance of the comment sheet and student-teacher conference in the learning process (discussed below) is evident, however, since Randy benefited from both forms of feedback. His revised text earned Randy a final B grade for the course and praise for "Very good work!" from Professor Dickson.

COMMENT SHEETS AND CONFERENCES

All writers found the comment sheet useful for providing a detailed assessment of their report (see appendix C). Since the list of evaluation criteria are extensively detailed and specific, writers gained an overall understanding of their strengths and weaknesses from information contained on the comment sheet. This response often worked in conjunction with the various annotations and comments written within the report itself. Writers generally found the complementary nature of the comment sheet and text notations useful, however graphic marks like underlining, asterisks, question marks, and arrows within the text were not clear unless these had been explained on the comment sheet.

In addition to the written feedback, however, many writers, particularly at the Technical Paper I level, found it either necessary, useful, or both, to consult with the instructor after they had received their written feedback. In some cases students were not clear about how to revise some aspects of their paper from reading the comment sheet alone. These writers were therefore able to have feedback elaborated and clarified while conferencing with their instructor. Similarly, other writers felt they could revise without meeting with the professor, however the conference enabled these students to confirm interpretations of written feedback and subsequently revise with greater confidence.

Students who met with their instructor were influenced in two ways: one is that writers gained a generally clear, focused, and succinct understanding of <u>how</u> the paper should be revised; and the second is that writers developed an overall understanding about <u>why</u> such changes were necessary. Conversely, students who did not attend a conference were not always certain about how to correct their report; nor were they

always clear of the basis for making specified revisions. Compare, for instance, the comments from two Technical Paper I writers.

In trying to explain the logic behind the basis for required revisions, Dean rather pointedly states that his subjective statements have to be quantified because "it has to be universally understandable - it has to mean the same - it has to be obvious to everybody." Even though he hesitates in trying to find the correct phrase, he remains focused on trying to make the same point because he recognizes the need for a universal or shared understanding of his report based on his conference discussion with Professor Dickson. Margo, however, is less certain about why she must make the changes she has been asked to provide, as evidenced in the following somewhat erratic response, since she did not attend a student-teacher conference:

> To make it um, right now, if someone were to read this they wouldn't come out saying O.K., this is the method where you should use - they wouldn't have any concrete thing - possibly jeopardize their career by saying O.K., use this process because so and so, and like if they had the concrete, if it lead them to the point where they were sure that it was the best way, but this paper doesn't do that right now. It's too subjective and too vague, I guess, mostly subjective, and the references aren't clear.

Among the students who did not attend a student-teacher conference, their discussions contain numerous speculative comments when trying to decipher written feedback. The most common cues indicating their assumptions include statements such as "I don't know," "I think," "I'm not sure," "it's not clear," "I suppose," "got me," and "I assume." These writers were therefore able to absorb only that information which they could easily understand, hopefully correctly, based on their own interpretation of the feedback. As Jamie, a Technical Paper II writer explains, he studied the remarks on his comment sheet and in his paper only to the extent that "I could understand it immediately. I didn't graze through the text trying to understand his comments."

The following example from Doug, a Technical Paper II writer, demonstrates the extent to which students were sometimes confused when interpreting their feedback. Following a lengthy discussion in which he tries to analyze and explain a criticism about his essential and desirable criteria, Doug finally concedes that

> I'm as confused as you are, because that's what he seems to be saying there. I didn't - I don't understand exactly. It seems to me - what I interpret out of this, is he's upset because I brought two new criteria out of the blue....I don't know. I don't understand what he's saying, basically.

Unlike Doug, who did not attend a student-teacher conference, Jim has a clear, succinct understanding about why his introduction needs to be rewritten following his conference with Professor Branch. During that meeting, Jim is told he should move the part of his introductory comments about his criteria to the background section because, as Professor Branch explained to him,

> You don't talk about alternatives and criteria [in your introduction]. Just say I have a problem here, this is why I have a problem, this is what I've been asked to do, and here's how I'm going to do it. And that's all the introduction. And then you have a background saying what that big process is....Here, right now, you're kind of redundant.

During Jim's second interview to discuss his feedback, however, he is able to explain clearly how, and why, his paper must be revised:

> Some of this information could be introduced in the background. These first three criteria are actually described and stated in the introduction, and that's what he didn't want, so that's why it's straight out repetitive. So that paragraph from the introduction will go into the background to help explain it a bit better.

DATA COLLECTION INTERVIEWS

Researchers are typically concerned with both the positive and negative effects their presence might have on both the process and the subjects under their investigation.

Because of this, it was useful to probe writers to see if attending the interview sessions had helped or hindered their learning or writing in any way. Students in both levels emphatically stated that the interviews were "certainly not a hindrance." Writers in fact considered the sessions helpful in predominantly two ways.

Several writers found the interviews an effective way to verbalize feedback interpretations and to discuss how their texts should be revised. As one writer observed, "a good test for learning is to see if you can explain it to someone else." The discussions therefore enabled many writers to clarify their ideas, review conference discussions, and, in some cases, to think revisions through more carefully. Other writers maintained that the interviews gave an added purpose to the report writing exercise other than simply fulfilling an academic obligation. Some noted they could more clearly see the relevance of learning to write such a report in relation to the workplace and the need to be a more careful writer once they become a professional engineer. All of the writers indicated that the interviews made a minor contribution to their learning.

CONCLUSION

Overall, it appears that the process for learning the Technical Report format is generally effective for learners, particularly since B was the lowest final assessment for any of the writers in both classes. The data indicate that successful models, either a writer's own or someone else's, are necessary for learning. Writers need, however, to keep topics simple so they conform well to the format, thereby reducing, or, for second level writers, eliminating significant problems in the writing. For first course writers, they need to study their models to understand more than just <u>how</u> a paper should be

organized. They also need, it seems, to comprehend why the paper is given a particular organization, thereby seeing the text in its entirety rather than just from a superficial organizational aspect.

In conjunction with the models, writers also rely on the course handout as a reference for writing their documents. Not all sections of the rather lengthy handout are consulted so a shorter document might be of greater benefit to writers. The seminar is also helpful for some writers since this session gives greater understanding to various aspects of both the paper and the course. Overall, models, in addition to the seminar and handout, appear to provide an effective initial introduction to the technical report writing process. This is particularly true since Randy, the only writer not to rely on the learning process provided, experienced major difficulties unlike any of the other writers in either of the two groups.

Once writers completed the process leading to the evaluation of their first draft, they then received useful detailed feedback on a comment sheet. They also had annotations throughout their paper which they could also consult. Writers generally found this written feedback useful providing graphic markings were explained and comments elaborated well enough to be clear. For students unable to decipher feedback, and who subsequently did not attend a student-teacher conference, their learning was limited only to those comments which they could quickly and easily understand. These writers similarly lacked the logistics for understanding why certain factors in their writing were problematic.

Conversely, however, those students who attended a conference with their instructor had various comments and notions clarified. Moreover, many comments were clarified so writers could understand why various errors were problematic in the writing.

In many cases, students used the conference to reinforce their own interpretation of the feedback received. Overall, it is evident that talk is extremely beneficial to learning. This appears to be particularly true since writers even found their data collection interviews useful even though they were not given explicit direction for diagnosing or correcting errors during these sessions. Writers did, however, find the sessions useful to clarify their thinking and to check their understanding of the feedback they had received.

CONCLUDING DISCUSSION

The primary objective of the two instructors of the technical writing courses is to prepare students for technical report writing in the workplace. They recognize the need for employees to possess strong writing skills since an inability to compose effectively can restrict an engineer's professional advancement. This is particularly problematic since technical report writing is, according to the instructors, the most common writing task demanded of engineers working in the chemical process industry.

In an attempt to address this potential problem, the course is structured to teach students how to conduct and write a standardized analysis of alternatives in order to recommend a solution to an industrial problem. The first course introduces students to the technical report format and provides them with writing practice. The second then allows students to further refine their report writing ability. Ideally, once students have completed the report teaching and learning process, they should be prepared to deal with similar writing tasks once they become a professional chemical engineer.

A major purpose of the course, from the instructors' perspective, is thus to provide a bridge between the writing done in school with that done in the workplace.

For them, school and the workplace represent two rather distinct writing contexts, so the texts produced in each therefore require different writing abilities. Professor Dickson explains how the Chemical Engineering degree program typically focuses more on research and theoretical applications when students write rather than on issues with practical and commercial relevance. He maintains that students need both types of writing experiences if they are to be successful when working in industry.

The writing courses thus represent an attempt to have students experience writing for the workplace while in university. This means that there has to be some kind of alignment established between the two contexts so that the workplace can, in effect, be brought into the school. From current arguments among composition theorists and researchers, writing is dependent upon the contexts wherein that writing occurs in terms of the purposes for writing, readers for whom texts are intended, the writing conventions to be followed, and the ideas to be examined within a text. Thus, these features, as they occur within the workplace, ideally need to be recreated in the university classroom in order for students to participate fully in a workplace writing experience. The purpose for writing a technical report for a boss to resolve a chemical process problem, for example, would have to be fully enacted in the classroom.

Though there was an attempt to recreate this writing context in the classroom, it is clear from the discussions throughout this chapter that, for students, the writing remained a purely school-based exercise in which they first had to determine their teacher's knowledge and expectations, then write to satisfy these demands. The dominating expectation, of course, was the need to satisfy format requirements. Getting the structure right was consistently emphasized throughout the seminar by both instructors as well as in the course handout. Even when evaluating, the instructors first examined each report to

ensure it contained the correct structural components. The first item in part one of the comment sheet asks, "does the report have the elements of a technical report?" (see appendix C). Conformity to these elements served as the basis for a "go/no-go" decision in terms of whether or not the report would be critiqued and evaluated, or returned with an F for revision. Those writers who did not subscribe to the required format for their first report submission quickly learned the importance of structure from the feedback and assessment they received. Even though some writers continued to experience weaknesses with form in their writing, they nevertheless understood the significance placed on mastering the imposed structure.

The emphasis on form is further reinforced by the much lesser importance placed on content. What students chose to write about seemed irrelevant other than that the topic needed to conform well to the format. The writers who earned an A on their first drafts, all from the second course, were the ones who best understood the insignificance of their content in terms of demonstrating knowledge of the discipline since they each found a book that examined device alternatives to various problems and simply adapted this information to fit the required form. It made no difference, in terms of evaluation, whether students chose a complex subject or selected an easy topic. Papers were graded on the same criteria, the predominant one of which was to ensure the required report sections were complete.

This lesser significance on content raises yet another dimension of the teaching and learning environment created for students. As discussed rather extensively in Chapter Two, reading and writing are reciprocal activities in the sense that students learn how to write for their discourse community by reading the texts of that environment, and similarly learn how to read within their community by writing. Within the Technical

Report writing courses, this reciprocity does not really enter into the language learning context of the classroom. The focus is on the writing to such a degree that students neither bring to nor discuss in class the texts they rely upon to help with their writing.

Writing style became a sub-issue of the form requirement since content had to be presented in a clear, concise, and persuasive manner. This meant that subjective statements had to be quantified and stated in measurable terms. If, for example, "easy to use" was one criterion for device alternatives, then students had to define what they meant by "easy" to ensure all potential report readers would share the same understanding. Data used in the reports were considered correct unless an obvious error existed, and, where actual data measurements were unavailable, students were advised to estimate device limits. Writers also had to avoid using "flowery language" and ensure their texts were correct in terms of grammar, sentence structure, and punctuation.

Most writers eventually realized the level of technical treatment required for a topic and learned to quantify data sufficiently. While an insufficient technical treatment remained a problem for some writers, it was not enough to warrant a grade below B on any of the final submissions. On the other hand, developing a clear, concise and succinct writing style remained more of a problem for some learners. Even though most students were able to refine their writing style, two level II writers and three level I writers continued to experience stylistic difficulties, even after revising their first drafts.

This teaching, learning, and evaluation focus on the form and writing style, along with a lesser treatment of the content, generates a need to consider a basic, fundamental purpose for writing. Composition researchers and theorists have both examined and discussed (see Chapter Two) the way in which members of a discourse community rely on their specialized discourse to speak about the ideas that have currency within a group,

and to similarly write, following conventions, about their ideas as well. As a community's members acquire new ideas, these are recorded in texts and distributed throughout the group, thereby ensuring that the discourse community is sustained. The purpose behind most texts is thus based on sharing knowledge with others in the community, be that simply to present ideas in order to inform, or to argue a particular viewpoint.

The predominant purpose for writing in a community, then, is to communicate knowledge and ideas to others. Knowledge is not isolated from or less important than the discourse used to convey that knowledge, nor is it less important than the forms or ways that knowledge and discourse are packaged. The elements of knowledge, discourse, structure, and writing conventions, when motivated by a need to share ideas with others, work collectively to ensure ongoing communication within a community. Insofar as the technical writing courses are concerned, the emphasis placed on form, grammar, and writing style, along with the lesser significance given to content, means that knowledge is significantly distanced or separated from its discourse, form, and writing conventions. Students thus do not write because of a genuine desire or purpose to share knowledge with interested others in their community, but motivated by the need to show their teacher that they have mastered the report formula. They write to the form, and, in so doing, write to meet teacher-expectations.

A professional composing situation has therefore not been recreated for students since knowledge, discourse, conventions, and form are neither treated nor perceived as equal elements working collectively to ensure purposeful and effective communication. A professional context also fails to be created since report readers are not those interested in the ideas of writers, but rather they are interested in making sure structural requirements

are met. As the data analysis shows, not all writers could fully understand that their reader's interest was in form rather than content.

Reader analysis was thus problematic for most writers, not only because of the real interest of the readers in form, but also because students were instructed to write for a dual readership - an overworked boss and the teacher. Once writers identified a reader, they then had to assess accurately that reader's level of background knowledge. In most cases, writers who wrote for a boss assumed that reader knew a lot about their topic and therefore failed to include an appropriate amount of background and contextualizing information. Similarly, writers who assumed their teacher-as-reader knew a considerable amount about a topic also needed to include greater detail. Overall, there were more problems for those writers who imagined a boss as the reader of their report. Conversely, students who wrote for the teacher and accurately assessed what he knew about their topic experienced fewer difficulties.

Successful writers understood, then, the need to write for a teacher-as-reader both in terms of the level of information provided as well as the form, level of technical discussion, and writing style required. In effect, for successful writers, the technical report writing experience was reduced to an academic exercise where students wrote to the text and to the teacher. This writing to text and teacher was particularly evident since students understood that what they actually wrote about was not overly significant. Successful writers, specifically those in the second writing course, recognized the need to meet teacher and text requirements so they selected simple topics that moulded well to the form. Those who simply studied the literature specifically for device selections and chose a topic that adapted easily to the requisite form, then wrote a paper that satisfied the technical and stylistic demands of their instructor, received an A on their first

submission. Conversely, those who wrote about topics of personal interest, sought to improve their technical writing ability, and took risks with both their writing and ideas were not as successful.

Content was thus simply to be of a technical nature and written in a reasonably technical manner. Students were not required to solve a real problem, thereby offering new or necessary information to a reader, nor were they expected to acquire new knowledge about their profession through writing the report. Writers who selected topics to extend either their knowledge or technical writing ability were penalized by needing to revise before earning an A on a final submission, or simply unable to satisfy all demands well enough to warrant an A.

It was mentioned earlier in this chapter that the report format taught to students was distilled from a variety of texts by the instructors as well as based on their personal writing experiences during their many years in the workplace. They have, in effect, determined a generic technical report format and made the learning of this structure the focus of their instruction. It was also discussed earlier in this chapter that the teaching of a genre based purely on textual features reduces identifying genres strictly according to their structural elements.

Composition researchers and theorists now argue that genres are not purely or predominantly comprised of their textual characteristics alone (see Chapter Two for a lengthier discussion). Genres emerge within a discourse community when a composing need is repeated and the subsequent response given to that need is similarly repeated. Genres become stabilized because texts are highly intertextual within a community. Writers, when learning to write a document, consult other texts written in response to the same situation and learn what conventions to follow. Based on this perspective, a genre

is thus the reiteration of a contextual purpose as well as textual features, so form alone does not represent a given genre. Students not only lack personal motivation or purpose for communicating knowledge, but they are also restricted from learning the socially driven purposes within an engineering community for writing technical reports. Since students are taught only one, generic, standardized form for the report, and since this one format is both dictated and demanded by an instructor, then students do not become familiar with either the naturally occurring purposes for writing a technical report, or learn the various types of appropriate responses.

Naturally occurring purposes and responses means that in an authentic professional chemical engineering context, the need to write technical reports naturally occurs since this is a genuine task demanded within the profession. Because technical report writing purposes vary in different professional contexts, so must their responses in elements like content, length, style, and structure. In school, students are given only one purpose for writing a technical report, to learn the format for an academic exercise, which does not reflect a naturally occurring purpose generated by a professional engineering context. The response given to this purpose is also not a reflection of a legitimate work context, particularly since students are allowed, and therefore know, only one way of responding. In terms of the intertextuality of texts, students consult other documents, but that is primarily for the purposes of consulting other technical reports written by other students to ensure they follow the correct format.

Given the focus on learning the prescribed technical report format, students were also unable to see the connection between this report and any of the other documents written by chemical engineers. Only three of the sixteen writers in this study recognized the shared problem-solving function of the three major writing requirements of their

degree program. Most writers perceived the technical report as a completely new writing experience and subsequently saw the text as unconnected to other documents written while in school. Students were therefore unable to conceptualize the technical report as just one type of problem-solving text which writers, as engineers and problem-solvers, are required to write within their profession.

Writers did, however, recognize the technical report itself as a problem-solving document even though they failed to see the basic function this text shared with other program writing requirements. Part of this inability to see a similarity in function stems from the concerted effort of the instructors to distinguish the technical report from other documents written in school. The instructors frequently noted that following a lab or design report format, or relying on material from other courses, was completely inappropriate for writing the technical reports.

In addition, the instructors repeatedly reinforced the practical and commercial application that learning a technical report would serve for writers once they entered the workplace. While both the Lab and Design courses similarly reflect tasks demanded of a professional engineer, these classes emphasized oral presentation development and course content even though writers produced a 40-50 page document. These large texts posed little problem for writers, however, since they wrote in groups and texts were not critiqued. Writing development was therefore not emphasized in any courses other than the Technical Report courses. The report is, then, in effect established as something unique by the instructors, so students similarly consider the technical report as new and unfamiliar.

Though the instructors say and think that they want to teach students how to write for the workplace, the actual agenda of the technical writing courses was to teach a

generic report format and to help writers develop a more succinct and persuasive writing style. These elements for success were, whether consciously or unconsciously, set and imposed by the instructors. Those learners without a clear focus on this real agenda - those who did not target the teacher as their real reader, who did not correctly assess the teacher's level of background knowledge, who did not recognize form as the primary learning objective, and who did not develop an appropriate writing style - were penalized in their assessment.

Based on the final comments and evaluations for all of the students in both writing classes, it is clear they have learned how to write a technical report in terms of form, style, and content since all writers passed the course. Though they have not fully learned how to write for their professional discourse community, students have succeeded in learning the conventions expected from their real writing context - the academic discourse community of chemical engineering at Eastern. An academic obligation has been fulfilled, and students have generally learned to structure and write a technical report.

In the context of this community, the teaching, learning, and evaluation processes for the two courses have been highly successful for that of the real agenda. But the goal of providing students an opportunity to experience writing for the workplace has not been accomplished with either the objectives set for this course, nor the learning format implemented by the instructors. Students are not able to achieve the overall perceived objective of the instructors, that of experiencing an authentic workplace writing demand, because an environment conducive to such learning has not been created for writers.

Learning report writing elements was facilitated initially through the course handout and the writing seminar, and augmented independently by writers when they consulted several A papers written by other students. Novice writers particularly needed

the added dimension of studying reliable report models which students independently obtained from other students. Writers who read other papers to understand how parts worked together met with greater writing success. The effectiveness of using models was also evident since one of two writers who did not attend the seminar neglected to study any models, thereby failing even remotely to meet form, content, or writing style requirements. Conversely, the writer who used models, even though she had not attended the seminar, met with considerable writing success. The use of such models was not a prescribed part of the learning process since instructors neither provided nor recommended their use to writers.

Writing practice was also provided, of course, since writers in both courses were able to revise their first submission and have this text reevaluated. Practice therefore worked, to varying degrees for each writer, in conjunction with extensive written feedback. Students not only received considerable notations on the report itself, but were also given detailed comments on an evaluation sheet. At this point in the process, writers then had three options: not to revise and keep the mark given; to revise based on notations and the comment sheet; or to attend a student-teacher conference and discuss required changes.

Whatever option students selected generally impacted their level of technical report writing knowledge and ability. Those who chose not to revise, or revise based on written feedback alone, could only absorb information which they could understand and interpret on their own. In many instances, graphic notations such as underlining, questions marks, and arrows, as well as many written statements, remained unclear. Writers could only therefore comprehend what they interpreted, hopefully correctly, based on their own analysis of the feedback.

In addition, these writers frequently failed to understand why specific changes were required even though they may have recognized what and how to revise based on the instructor's feedback. In other words, writers often did not understand the logic behind requested revisions. Conversely, writers who discussed feedback and required revisions during their student-teacher conference possessed a more thorough understanding of the changes needed. They also acquired a more comprehensive awareness of the logic governing why such modifications were required.

Based on comments in the student interview transcripts, the element of talk became a major component in the technical report learning process. It gave writers an opportunity to clarify or simply reinforce interpretations of both graphic and written notations. It also allowed writers to engage in a more thorough discussion and analysis of their report which contributed to their overall understanding of the form, function, and writing conventions of the text itself. The significance of talk was particularly reinforced in this study since writers even found some value in talking about their papers during data collection interviews. Students who did not follow this overall learning process relatively closely failed in some way to discover the real agenda for the course, that of learning to write a technical report as an academic exercise according to the expectations of the instructors. They did not understand that the real purpose for the course was to learn the format and a particular composing style, and thus made significant errors in their first draft submissions. Based on annotations in their texts, the evaluation comment sheets, and student-teacher conferences, students then had ample opportunity to revise their misperceptions and better align their objectives with those of the instructors in order to revise their reports.

CHAPTER V - IMPLICATIONS FOR TEACHING AND RESEARCH

INTRODUCTION

This study is important to the ongoing and evolving discussion of writers learning in their discourse communities in two significant ways: first, it supports the theory that writing is a socially motivated and determined activity; and second, it sheds light on the difficulties associated with trying to imitate the nature and demands of a professional environment within the classroom. In light of these two central dimensions of the research, this investigation offers insights into the way teachers teach, how students learn, what they learn, and how both implicit and explicit assumptions about teaching and learning direct the educational process. This chapter explores these findings and their implications for teaching and learning, and further proposes teaching and learning alternatives both generally and specifically within the context of the Technical Report courses investigated in this research.

KEY FINDINGS AND CONTRIBUTIONS

The findings of this study support the theory that writing is essentially a social activity. In examining the teaching and learning process of these students, it is evident that these writers were motivated to compose by responding to a writing purpose within their social context. For these writers, however, a significant issue became one of determining the actual, true, and authentic purpose for writing. The professors tried to create a sense of purposeful writing for the workplace among students by stressing the importance of strong writing abilities in the chemical engineering profession, asking

students to write for an imagined boss, and providing a document model distilled from a variety of report types within the profession.

The data indicate, however, that those students who believed these course objectives to be true were, to varying degrees, unsuccessful with their report writing. Writers who met with success on their first draft recognized the real writing purpose as one of writing to master the form in order to satisfy teacher expectations. Since students who had problems with their writing in the first draft were able to revise their texts, they similarly adjusted their course perceptions to understand that the real purpose for writing was to supply the right report formula for the instructors. The elements of talk, among students and between students and their professors, along with oral and written report feedback, were necessary for moving students toward a more precise understanding of their reasons for writing.

This study therefore points to the necessity for educators to be aware of their "real" teaching agenda and ensure that students know what they are being asked to learn in order to meet with success in any given course. From the data, it is clear that most of the Technical Paper II students knew the real agenda because of what they had learned from their first report writing experience. Writers among this group with a direct focus on meeting teacher expectations earned an A on their first submissions. Those who still, in spite of what they had learned from Technical Paper I, wanted to learn more than just the formula from the writing opportunity had to revise their papers and, for some, were not rewarded with an A on their final submission.

The data indicate that many of the first course writers struggled to identify the real agenda for the course. Several students received a D or F on their first submissions and had to revise both their papers and their perceptions of the course objectives in order to

earn a better grade on their second report. Not all writers fully understood the expectations of their instructor and how to satisfy these demands even after feedback and revisions, so they subsequently continued to have problems with their second submission. This perception on the part of the instructors that the overall writing process is developmental for students in terms of both their knowledge and writing ability is somewhat of an irony. They assume that student writing ability is enhanced and that students are better prepared to write for their eventual workplace. Perhaps this is true. The scope of this study was not designed to consider the effects of student learning from these two courses in the workplace. (This issue is addressed further on in the research implications section of this chapter).

Nevertheless, workplace writing purposes are not typically based on demonstrating mastery of a particular document format for a boss or other such reader. Writing is most often done in the workplace to get something done. Without reiterating in detail the theoretical discussion of Chapter Two, both the writing purposes and the texts produced are generated by participants' needs within the writing context. Why a specific writing task is required, and how an author responds to this by selecting appropriate textual conventions to meet the demands of the writing purpose, are both determined by the social context of the writing. This is not the cause and effect relationship for writing carried away by students from the Technical Report writing courses. Their writing cause, and ultimately the effect, is to give the teachers what they want in the final report format. The ability to do this is, of course, based on the assumption that students have suitable control over their knowledge and writing ability such that it allows them to structure ideas in the right form and express thoughts in a reasonably coherent manner.

This study also adds to the discussion of writers and learning in discourse communities in a second way by considering the difficulties of creating the workplace in the classroom. Problems with trying to accomplish this were not only evident in the Technical Report courses as discussed throughout Chapters Four and Five, but were also apparent from the **Creating the Writing Environment** section of Chapter Four. That section was a discussion of the chemical engineering program courses wherein students were required to do a considerable amount of writing. In these courses, Project Laboratory Parts One and Two, Process Design, and Design Project, students had to solve chemical engineering experimental and design problems and submit their findings in a major final report. These four courses, in combination with the Technical Report courses, constitute the bulk of the learning environment where students are expected to use their discourse, knowledge, and writing conventions to produce written texts.

Throughout the student interviews conducted for this study, learners consistently expressed an appreciation for the Lab and Design courses where their writing was done for a client external to the university. In both cases, students were assigned a problem by an outside client and their work had to be done to satisfy the demands of this "boss." Students saw their writing as having a legitimate purpose and the problem-solving aspect of the activity tended to dominate their learning focus. The quality and overall effectiveness of the writing they produced, however, was given minimal attention by instructors. Students knew that the focus for evaluation was on their learning process and the knowledge they produced. They also knew their final reports would be given relatively little weight in that assessment. In contrast, students knew or eventually figured out that they wrote their technical reports strictly for their teacher, that his expectations had to be met, and that the final product was the only element for

assessment. Attention to content was minimal in that ideas had to be discussed and presented accurately, but there was no expectation that students would learn much that was new about their profession.

To a significant extent, the Lab and Design courses and the Technical Report courses are at opposite ends of the continuum in terms of balancing the emphasis placed on knowledge, discourse, conventions and writing purposes in student learning. As mentioned in Chapter Two, knowledge is mediated through discourse, both of which are social constructs of a community, and reading and writing the texts of a community are integral to the shaping and learning of communal ideas. The importance of writing for a legitimate purpose has also been emphasized throughout this study. In order to recreate a professional community within an academic context, the role of a community's language, how it relates to knowledge, and the ability to use that knowledge and language for authentic communicative purposes need to be given equal emphasis or balance in the learning environment.

The writing done in an academic context must, as the writing done in its professional counterpart, be motivated by a genuine need to write about communal ideas in order to share information with other members. In their professional context, these students will use their writing to outline an analysis of alternatives and offer a solution for solving a problem relevant to the chemical engineering industry. In this instance, the ideas conveyed through the report are just as important as ensuring that format and writing style meet reader-expectations. In the engineering writing classroom, however, format and style take priority over content, so writing purpose does not reflect their eventual workplace. Identifying a community's genres based purely on textual features and then isolating these as the basis for learning means that students understand only the

form and do not recognize the broader social implications or purposes of the texts they produce.

None of the elements for communication can be given less significance if students are to learn to write for professional purposes. Students would therefore benefit from engaging in university-based writing activities that are motivated by a more meaningful purpose than simply writing to satisfy format requirements. Students similarly need to write for readers other than just teachers intent on ensuring that learners master an imposed, required format. Writing should happen because of a genuine need to communicate information. When the need is there, students then use the knowledge, discourse, and writing conventions of their community to be effective communicators.

IMPLICATIONS FOR TEACHING

It was discussed in Chapter Two that university writing classes typically separate knowledge from discourse and writing conventions since they tend to offer general characteristics of academic writing rather than teach students how to communicate in a specific community. While writers may benefit from learning these generalist notions of academic writing, they also need to learn how to write well for the professional contexts they choose to enter. General composition courses cannot provide this more specialized level of writing instruction since classes consist of students from a variety of disciplines, and instructors are not always familiar with the knowledge and discourse conventions of the disciplines students choose to study.

There is a need, then, for the various study programs of the professions to focus more on the writing needs of their learners. In the discussion that follows, a proposed

teaching and learning format for the Technical Report writing courses is outlined in order to demonstrate how the Chemical Engineering Department might create an environment that more closely reflects a professional discourse community for learners. Rather than addressing the implications of this research for teaching entirely from a theoretical perspective, it is useful to examine how key changes in this specific teaching, learning, and evaluation process would enable the university to enact a more authentic professional writing situation in school.

As the Chemical Engineering Department now exists, students develop a major plant process in their Design Project course and write two technical reports for their writing classes. As discussed in Chapter Four, most students were unable to recognize the shared problem-solving function of the Design and Technical Reports because of the focus on format in the Technical Report writing courses. This inability to see any relationship was further compounded when students were told by the instructors that they should not select a topic from another course when writing their technical reports. They were therefore unable to experience the dynamic, interactive nature of an authentic workplace context where different types of problem-solving reports are written for a variety of purposes.

One way to overcome this disparate treatment of texts is to connect the technical report to the major design project. Students work on designing an industrial process over an entire school year and therefore possess considerable knowledge about how this particular process should function. Since a technical report deals with only one aspect of an operation, students, or a teacher acting as a boss, could isolate a particular problem within the overall industrial design for which students would then conduct a problem-solving analysis of alternatives and recommend a solution.

The technical report instructors then become the busy, overworked bosses who must decide whether or not to accept the recommendations of the student engineers. Since students write an abstract outlining where their project comes from, which is currently a hypothetical worksite or based on previous work experience, they could use this abstract to explain the nature of their design project and identify the problem to be addressed in their technical report. There is also a background section for writers to provide additional information about either their overall process or the specific problem of the technical report. Such a unified learning context thus elevates writing purposes from simply learning the technical report format and writing to meet teacher-expectations to one of writing to inform and advise a busy reader - a scenario the instructors already attempt, but fail to create in the report writing courses.

The purpose of writing to inform can be sustained if feedback is based on the reader's inability to understand clearly what writers are saying or if the report lacks significant information rather than simply telling students what the teachers are looking for in terms of correct format. When, for instance, writers do not qualify subjective statements like "easy to use," then a reader's genuine reaction is the need to have such comments quantified. Students would then strengthen their learning and writing ability by submitting drafts to their "boss" until such time as their reports are written well enough for this boss to make a decision on the recommended course of action. Oral presentations could also be incorporated into the writing courses just as they now are in the Project Lab and Design Process courses if "employees" are asked to present their ideas to their "boss."

Rather than asking all students to follow an identical format, students, through meetings with their instructors, would strengthen their understanding of the purpose of a

technical report, learn what these reports should contain in order to meet their purpose, and be able to write a report based on the nature of each writing context according to the problem they are attempting to solve. Writers can further learn how other reports are organized and presented if they are given time to edit and proofread the reports of other students working on similar problem-solving projects. By relating the technical report to the Design Project in this way, the department can develop a professional chemical engineering discourse community more fully within the academic environment. Rather than dealing with the information to be learned in discrete sections as it now is, courses and their various content areas are related. By connecting courses to one another, there is thus a relationship between ideas, just as there is a comparable relationship between ideas in the knowledge of a professional discourse community.

The academic community is then highly intertextual as students read to become better informed of their community's knowledge and discourse, and then use this knowledge to convey their own ideas in the appropriate discourse and writing conventions. University classrooms therefore need to create environments where these elements are enacted as they naturally occur in their professional context; where knowledge, discourse, and conventions are both related and used by writers to satisfy legitimate writing purposes. Educators cannot simply ask students to pretend they are writing for a purpose and readers of the workplace. The profession itself needs to be enacted within an academic community context in order for students to experience "being" a member of their profession. They need to be members united by shared interests working together on meaningful projects where learning the discourse, interpretive strategies, writing conventions, and genres are inherently necessary and purposeful because they help get things accomplished within the community.

IMPLICATIONS FOR RESEARCH

It was mentioned earlier that the scope of this study does not allow for an assessment of student writers in the workplace in order to determine the long-term uses and effects of the report writing courses. Findings from an investigation that follows student chemical engineering writers through school and into the workplace would reveal much about how well their academic community prepares them for writing at work. It would also be valuable to follow the same group of students through both levels of the Technical Report courses. An investigation of this design would strengthen the understanding of what students take with them from the paper I writing course and what information they subsequently rely upon to assist them with their second report writing requirement. Findings from both of these proposed research directions could then be used to inform the teaching, learning, and evaluation practices in both courses.

A more detailed study could also be conducted to observe students in Project Laboratory and Design courses in addition to the Technical Report writing classes. This would then create a more comprehensive understanding of the types of texts chemical engineering students must write, how these texts relate within the community, and the extent to which the academic community builds an integrated language-using environment for learners. As with the proposed directions for research identified above, findings from this investigation could then inform instructional practices within the department.

Finally, studies investigating student writers in academic contexts should continue to be conducted, and the number of discipline areas examined should be expanded. These studies should include both explicit attempts by institutions to teach students the writing conventions of their discipline as well as research settings that do not overtly emphasize writing ability. More studies of this nature, in addition to those that already

exist, would allow for a comparison of the findings from a number of research studies. Such a comparison would allow researchers and theorists to develop a stronger, more comprehensive, and more broadly based understanding of discipline-specific writing development within respective academic contexts. The insights gained from this accumulated research could offer considerable direction to teachers and administrators responsible for educating students to join particular professions.

REFERENCES

Anderson, G. (1990). Fundamentals of Educational Research. London: The Falmer Press.

Bakhtin, M. (1986). Speech Genres and Other Late Essays (V. McGee, Trans.). Austin: University of Texas Press.

Baldick, C. (1990). The Concise Oxford Dictionary of Literary Terms. Oxford: Oxford University Press.

Bartholomae, D. (1985). Inventing the University. In Mike Rose (Ed.), When a Writer Can't Write (pp. 134-165). London: The Guilford Press.

Bazerman, C. (1985). Physicists Reading Physics. Written Communication, 2(1), 3-23.

Bazerman, C. (1987). Difficulties in Characterizing Social Phenomena of Writing. Paper presented at the Conference on College Composition and Communication, Atlanta.

Bazerman, C. (1988). Shaping Written Knowledge. Madison: University of Wisconsin Press.

Bazerman, C. & Paradis, J. (Eds.). (1991). Textual Dynamics of The Professions. Wisconson: The University of Wisconsin Press.

Becker, Howard. (1986). Writing For Social Scientists. Chicago: The University of Chicago Press.

Berger, P. & Luckmann, T. (1967). The Social Construction of Reality. New York: Anchor Press.

Berkenkotter, C. (1981). Understanding a Writer's Awareness of Audience. College Composition and Communication, 32, 388-399.

Berkenkotter, C. (1991). Paradigm Debates, Turf Wars, and the Conduct of Sociocognitive Inquiry in Composition. College Composition and Communication, 42(2), 151-169.

Berkenkotter, C., Huckin, T., & Ackerman, J. (1988). Conventions, Conversation, and the Writer: Case Study of a Student in a Rhetoric Ph.D. Program. Research in the Teaching of English, 22(1), 9-44.

Berkenkotter, C. & Huckin, T. (1992). Rethinking Genre From a Sociocognitive Perspective. Paper Presented at the Rethinking Genre Conference, Ottawa.

Berlin, J. (1982). Contemporary Composition: The Major Pedagogical Theories. College English, 44(8), 765-777.

Berlin, J. (1988). Rhetoric and Ideology in the Writing Class. College English, 50(5), 477-494).

Bitzer, L. (1968), The Rhetorical Situation. Philosophy and Rhetoric, 1, pp. 1-14.

Bizzell, P. (1982). Cognition, Convention, and Certainty: What We Need to Know About Writing. Pre/Text, 3(3), 213-243.

Bizzell, P. (1986). Foundationalism and Anti-Foundationalism in Composition Studies. Pre/Text 7, (1-2), 37-56.

Bizzell, P. (1987). What is a Discourse Community? Paper presented at the Conference on Rhetoric and Composition, Penn State.

Bogdan, R. & Biklen, S. (1982). Qualitative Research for Education. Boston, Mass.: Allyn and Bacon, Inc.

Brandt, D. (1986). Toward an Understanding of Context in Composition. Written Communication, 3, 139-157.

Brodkey, L. (1987). Academic Writing as Social Process. Philadelphia: Temple, UP.

Bruffee, K. (1984). Collaborative Learning and the "Conversation of Mankind." College English, 46(7), 635-652.

Bruffee, K. (1986). Social Construction, Language, and the Authority of Knowledge: A Bibliographical Essay. College English, 48(8), 773-790.

Carter, M. (1988). Problem-Solving Reconsidered: A Pluralistic Theory of Problems. College English, 50(5), 551-565.

Christensen, F. (1967). Notes Toward a New Rhetoric: Six Essays For Teachers. New York: Harper and Row.

Christensen, F. & Christensen, B. (1976). A New Rhetoric. New York: Harper and Row.

Cooper, C. (Ed.). (1985). Researching Response to Literature and the Teaching of Literature: Points of Departure. Norwood, N.J.: Ablex.

Cooper, M. (1986). The Ecology of Writing. College English, 48(4), 364-375.

Cooper, M. (1989). Why Are We Talking About Discourse Communities? In Marilyn Cooper & Michael Holzman (Eds.), Writing as Social Action (pp. 202-220). Heinemann, N.H.: Boynton Cook Publishers.

Currie, P. (1992). Initiation into a Disciplinary Community: Enculteration and Evaluation. Paper Presented at the Rethinking Genre Conference, Ottawa.

Davies, B. (1982). Life in the Classroom and Playground. London: Routledge & Kegan Paul.

Devitt, A. (1991). Intertextuality in Tax Accounting. In Charles Bazerman and James Paradis (Eds.), Textual Dynamics of the Professions (pp. 336-357). Wisconson: The University of Wisconson Press.

Dias, P. (1987). Making Sense of Poetry. Ottawa: CCTE.

Dias, P., & Hayhoe, M. (1988). Developing Response to Poetry. Milton Keynes: Open University Press.

Dias, P., Beer, A., Ledwell-Brown, J., Paré, A. & Pittenger, C. (1990). Writing For Ourselves/Writing For Others. Montreal, Quebec: Centre for the Study and Teaching of Writing.

Dixon, J. (1967). Growth Through English. London: NATE.

Doheny-Farina & Odell, L. (1985). Ethnographic Research on Writing: Assumptions and Methodology. In Lee Odell and Dixie Goswami (Eds.), Writing in Nonacademic Settings (pp. 503- 535). New York: The Guilford Press.

Ede, L. & Lunsford, A. (1984). Audience Addressed/Audience Invoked: The Role of Audience in Composition Theory and Pedagogy. College Composition and Communication, 35(2), 155-171.

Elbow, P. (1973). Writing Without Teachers. New York: Oxford University Press.

Elbow, P. (1991). Reflections of Academic Discourse: How it Relates to Freshman and Colleagues. College English, 53(2), 135-155.

Emig, J. (1971). The Composing Processes of Twelfth Graders. Illinois: NCTE

Faigley, L. (1985). Nonacademic Writing: The Social Perspective. In Lee Odell & Dixie Goswami, (Eds.), Writing in Nonacademic Settings (pp. 231-247). New York: The Guilford Press.

Faigley, L. (1986). Competing Theories of Process: A Critique and A Proposal. College English, 48(6), 527-542.

Faigley, L., and Hansen, K. (1985). Learning to Write in the Social Sciences. College Composition and Communication, 36(2), 140-149.

Fish, S. (1980). Is There a Text in This Class? Cambridge, Mass.: Harvard University.

Flower, L. (1985). Problem-Solving Strategies for Writing (2nd ed.). San Diego: Harcourt Brace Jovanovich.

Flower, L. & Hayes, J. (1977). Problem-Solving Strategies and the Writing Process. College English, 39, 449-461.

Flower, L. & Hayes, J. (1980a). A Cognitive Process Theory of Writing. College Composition and Communication, 31, 365-387.

Flower, L. & Hayes, J. (1980b). The Dynamics of Composing: Making Plans and Juggling Constraints. In L. Gregg & E. Steinberg (Eds.), Cognitive Processes in Writing (pp. 31-50). Hillsdale, NJ: Lawrence Erlbaum.

Flower, L. & Hayes, J. (1980c). The Cognition of Discovery: Defining a Rhetorical Problem. College Composition and Communication, 31, 21-32.

Flower, L. & Hayes, J. (1981). A Cognitive Process Theory of Writing. College Composition and Communication, 32, 365-387.

Fontaine, S. (1988). The Unfinished Story of the Interpretive Community. Rhetoric Review, 7(1), 86-96.

Foucault, M. (1972). The Archaeology of Knowledge & The Discourse on Language. Trans. A.M. Sheridan Smith, New York: Pantheon Books.

Freedman, A. (1987). Learning to Write Again: Discipline-Specific Writing at University. Carleton Papers in Applied Language Studies, 4, 95-115.

Freedman, A. (1989). Reconceiving Genre. Texte, 8, 279-292.

Freedman, A. (1993). Show and Tell? The Role of Explicit Teaching in the Learning of New Genres. Research in the Teaching of English, 27(3), 5-34.

Geertz, C. (1983). Local Knowledge. New York: Basic Books, Inc.

Gold, R. (1958). Roles in Sociological Field Observations. Social Forces, 36, 217-223.

Grumperz, J. (1971). Language in Social Groups. Stanford, CA.: Stanford University Press.

Haas Dyson, A. (1984). Learning to Write/Learning to do School: Emergent Writers' Interpretations of School Literacy Tasks. Research in the Teaching of English, 18(3), 233-263.

Hairston, M. (1982). The Winds of Change: Thomas Kuhn and the Revolution in the Teaching of Writing, College Composition and Communication, 33(1), 76-88.

Hammersley, M. & Atkinson, P. (1983). Ethnography Principles in Practice. London: Routledge.

Harris, J. (1989). The Idea of Community in the Study of Writing. College Composition and Communication, 40(1), 11-22.

Heath, S. (1982). Ethnography in Education: Defining the Essentials. In P. Gilmore & A. Glatthorn (Eds.), Children in and out of School (pp. 33-55). Washington, Center for Applied Linguistics.

Herrington, A. (1985). Writing in Academic Settings: A Study of the Contexts for Writing in Two College Chemical Engineering Courses. Research in the Teaching of English, 19(4), 331-359.

Hertzberg, B. (1986). The Politics of Discourse Communities. Paper presented at the Conference on College Composition and Communication, New Orleans.

Hunt, K. (1965). Grammatical Structures Written at Three Grade Levels. Urbana, Ill.: NCTE.

Hunt, K. (1977). Early Blooming and Late Blooming Syntactic Structures. In C. Cooper & L. Odell (Eds.), Evaluating Writing: Describing, Measuring, Judging (pp. 91-104). Urbana, Ill.: NCTE.

Kantor, K., Kirby, D., & Goetz, J. (1981). Research in Context: Ethnographic Studies in English Education. Research in the Teaching of English, 15(4), (pp. 293-309).

Kress, G. (1985). Linguistic Processes in Sociocultural Practice. Oxford: Oxford University Press.

Kuhn, T. (1970). The Structure of Scientific Revolutions. (2nd. ed.). Chicago: University of Chicago Press.

Leavis, F. R. (1962). Two Cultures? The Significance of C.P. Snow. Middlesex: Penguin Books Ltd.

Ledwell-Brown, J. (1993). Reader Response to Writing in a Business Setting: A Study of Managers' Responses to Writing in an Organizational Culture. Unpublished Doctoral Dissertation, McGill University.

Lefevre, K. (1987). Invention as a Social Act. Southern Illinois University Press, Carbondale, Ill.: Conference On College Composition and Communication.

Loban, W. (1976). Language Development: Kindergarten Through Grade Twelve. Urbana, Ill.: NCTE.

Lofland, J. and Lofland, L. (1984). Analyzing Social Settings. California: Wadsworth Publishing Company.

MacDonald, S. (1987). Problem Definition in Academic Writing. College English, 49(3), 315-331.

Measor, L. (1985). Interviewing: a Strategy in Qualitative Research. In R. Burgess (Ed.), Strategies of Educational Research: Qualitative Methods (pp. 55-77). London: The Falmer Press.

Merriam, S. (1988). Case Study Research in Education: A Qualitative Approach. San Francisco: Jossey-Bass.

Miller, C. (1984). Genre as Social Action. Quarterly Journal of Speech, 70(2), 151-167.

Mishler, E. (1979). Meaning in Context: is There any Other Kind? Harvard Educational Review, 49, (pp. 1-19).

Mishler, E. (1986). Research Interviewing. Cambridge, Massachusetts: Harvard University Press.

Murray, D. (1978). Internal Revision: a Process of Discovery. In C.R. Cooper & L. Odell (Eds.), Research on Composing (pp. 85-103). Urbana, Ill.: NCTE

Myers, G. (1985). The Social Construction of two Biologists' Proposals. Written Communication, 2(3), 219-245.

North, S. (1987) The Making of Knowledge in Composition: Portrait of an Emerging Field. New Hampshire: Boynton/Cook.

Odell, L. & Goswami, D. (Eds.). (1985). Writing in Nonacademic Settings. New York: The Guilford Press.

Ongstad, S. (1992). The Definition of Genre and the Didactics of Genres. Paper presented at the Rethinking Genre Conference, Ottawa.

O'Hare, F. (1973). Sentence Combining: Improving Student Writing Without Formal Grammar Instruction. Urbana, Ill.: NCTE.

Paré, A. (1991). Ushering "Audience" Out: From Oration to Conversation. Textual Studies in Canada, 1, 45-64.

Paré, A. (1992a). Writing in Social Work: a case study of a discourse community. Unpublished Ph.D. Dissertation, McGill University: Montreal, Canada.

Paré, A. (1992b). Community Motives and the Control of Invention. Paper Presented at the Conference on College Composition and Communication, Cincinnati.

Paré, A. and Smart, G. (1992). Written Genre: A Profile of Regularities across Texts, Composing Processes, Reading Practices, and Social Roles. Paper Presented at the Rethinking Genre Colloquium, Ottawa.

Parkinson McCarthy, L. (1987). A Stranger in Strange Lands: A College Student Writing Across the Curriculum. Research in the Teaching of English, 21(3), 233-265.

Perl, S. (1979). The Composing Processes of Unskilled College Writers. Research in the Teaching of English, 47, 257-281.

Perl, S. (1983). Understanding Composing. In J. Hays & P. Roth (Eds.), The Writer's Mind: Writing as a Mode of Thinking (pp. 363-369). Urbana, Ill.: NCTE.

Philips, S. (1982). The Language Socialization of Lawyers Acquiring the "Cant." In George Spindler (Ed.), Doing the Ethnography of Schooling (pp. 176-209). New York: Holt, Rinehart and Winston.

Pianko, S. (1979). A Description of the Composition Processes of College Freshman Writers. Research in the Teaching of English, 13, 5-22.

Porter, J. (1986). Intertextuality and the Discourse Community. Rhetoric Review, 5, 34-47.

Reither, J. (1985). Writing and Knowing: Toward Redefining the Writing Process. College English, 47(6), 620-628.

Richards, I.A. (1929). Practical Criticism. New York: Harcourt, Brace, and World, Inc.

Rorty, R. (1979). Philosophy and the Mirror of Nature. Princeton: Princeton UP.

Rosenblatt, L. (1978). The Reader, The Text, The Poem. Carbondale: Southern Illinois University Press.

Schatzman, L. & Strauss, A. (1973). Field Research: Strategies for a Natural Sociology. New Jersey: Prentice-Hall, Inc.

Schryer, C. (1992). Records as Genre. Paper Presented at the Rethinking Genre Conference, Ottawa.

Schwegler, R. & Shamoon, L. (1991). Meaning Attribution in Ambiguous Texts in Sociology. In Charles Bazerman and James Paradis (Eds.), Textual Dynamics of the Professions (pp. 216-233). Wisconson: The Wisconson University Press.

Smart, G. (1992). Exploring the Social Dimension of A Workplace Genre and the Implications for Teaching. Carleton Papers in Applied Language Studies, Vol. 9, pp. 33-46.

Sommers, N. (1980). Revision Strategies of Student Writers and Experienced Adult Writers. College Composition and Communication, 31, 378-387.

Spradley, J. (1980). Participant Observation. New York: Holt, Rinehart, and Winston.

Stewart, M. (1978). Freshman Sentence Combining: A Canadian Project. Research in the Teaching of English, 12, 257-268.

Strong, W. (1973). Sentence Combining: A Composing Book. New York: Random House.

Swales, J. (1985). A Genre-Based Approach to Language Across the Curriculum. Paper presented at RELC, Singapore. (April).

Swales, J. (1987). Approaching the Concept of Discourse Community. Paper presented at the Conference on College Composition and Communication, Atlanta.

Swales, J. (1988). Discourse communities, genres and English as an international language. World English, 7(2), 211-220.

Vygotsky, L. (1962). Thought and Language. Eugenia Hanfmann and Gertrude Vakar, Eds. and Trans. Cambridge, Mass.: The M.I.T. Press.

Vygotsky, L.S. (1978). Mind in Society: The Development of Higher Psychological Processes. Michael Cole, Vera John-Steiner, Sylvia Scribner, & Ellen Souberman, Eds. London, England: Harvard University Press.

Winsor, D. (1990). Engineering Writing/Writing Engineering. College Composition and Communication, 41(1), pp. 58-70.

Yates, J. & Orlikowski, W. (1992). Genres of Organizational Communication: An Approach to Studying Communication and Media. Paper presented at the Rethinking Genre Conference, Ottawa.

Yin, R. (1984). Case Study Research. Beverley Hills: Sage Publications.

APPENDIX A
SAMPLE TECHNICAL PAPER

TECHNICAL PAPER II

302-462B

RESUBMISSION

SELECTION OF A TEMPERATURE CONTROL DEVICE

FOR:

Professor Branch

DEPARTMENT OF CHEMICAL ENGINEERING

SUBMITTED BY:

Jim

ID #

MARCH 9, 1992

ABSTRACT

Several temperature control devices were required for use in an experimental pyrolysis reactor. Nine separate locations in the high-temperature reactor required temperature monitoring and control. The temperature control devices had to process input signals from Type J and K thermocouples. The devices would have to transmit output signals to a chart recorder as well as heating elements. Precise controllers with safety features (alarms) were required for experimental uses of the reactor to maintain reaction control and reproducible results. This report concludes that the best temperature control device alternative is the OMEGA CN-7100. This device best meets all specified essential and desirable criteria, for a total cost (nine units) of $4185 (Can.).

ACKNOWLEDGEMENT

The topic for this work arose from summer employment wit Ensyn Engineering Associates in Ottawa. This firm is involved i the development and testing of a pyrolysis process. The autho would like to thank Barry Freel, Process Engineer, for hi assistance with various aspects of the temperature controlle topic.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

INTRODUCTION

An experimental pyrolysis system used for the conversion of used oil products requires temperature control devices for nine points (See figure 1) in a reactor. The temperature control devices (TCDs) are required for operation and control of individual heating elements. For ease of installation and maintenance, all nine reactor points should be controlled by identical devices.

A comparative analysis of available TCD alternatives will be based upon criteria classified as either essential or desirable. The results of the analysis will serve as the basis for selection of the best temperature control device alternative for use with the pyrolysis reactor.

BACKGROUND

Pyrolysis is the degradation of a compound in a high temperature, inert atmosphere (as opposed to combustion, which occurs in the presence of oxygen). In the Ensyn pyrolysis process almost any hydrocarbon can be fed to a reactor where it is decomposed rapidly to low molecular weight gases and a worthless solid slag. The economic benefit of the process is in recovering valuable reaction intermediate products. These intermediates are recoverable by quenching the reaction at a specific extent. The Ensyn pyrolysis system is composed of a tubular reactor with a quench unit near the end of the reactor (see figure 1). Following the reactor is a series of gas-solid separation and cooling units.

The high reaction temperatures required for pyrolysis are achieved using a heat carrier, sand, which is preheated in feed silos, mixed with the hydrocarbon feedstock and passed through the reactor. The quench system also uses sand. Ceramic heating elements surround each of the feed silos, the feed mixer and the reactor. Close monitoring and control of the temperatures along the process is vital. It ensures adequate heat is supplied for the reaction to proceed, that the sand is sufficiently heated in the silos, and prevents meltdowns (especially in the feed silos and mixer). Temperature controllers are used to control the temperature-sensitive reactor with a minimum of human involvement. The reactor temperature control system consists of input sensors (thermocouples), the controllers, and control elements (heaters).

The temperature control devices required for the pyrolysis system must be able to accept input from both high-temperature thermocouple probes (TYPE K) and low temperature probes (TYPE J) which are used to monitor the process. The TCD needs solid state relay (SSR) outputs as this type of signal is accepted by the heating units. Due to the temperature sensitivity of the pyrolysis reaction, precise PID control is vital. During start-up and cool-down periods, only On-Off control is required to keep temperatures within reasonable ranges. The TCD must have alarm outputs (including sensor break protection) to warn system operators of abnormal conditions. The sensitivity of the process dictates that temperature data be recorded with an accuracy of at least 1°C. Low values for repeatability and resolution will allow reproducible results when performing experimental runs. The devices must be programmable (ie. setpoints, auto-tuning, self-diagnostic functions) and be capable of communicating with a personal computer. These capabilities will allow for faster setup of experiments. The controller should have a digital display for ease of reading. The head engineer, Mr. Barry Freel, has budgeted $4500 for the purchase of the nine control units.

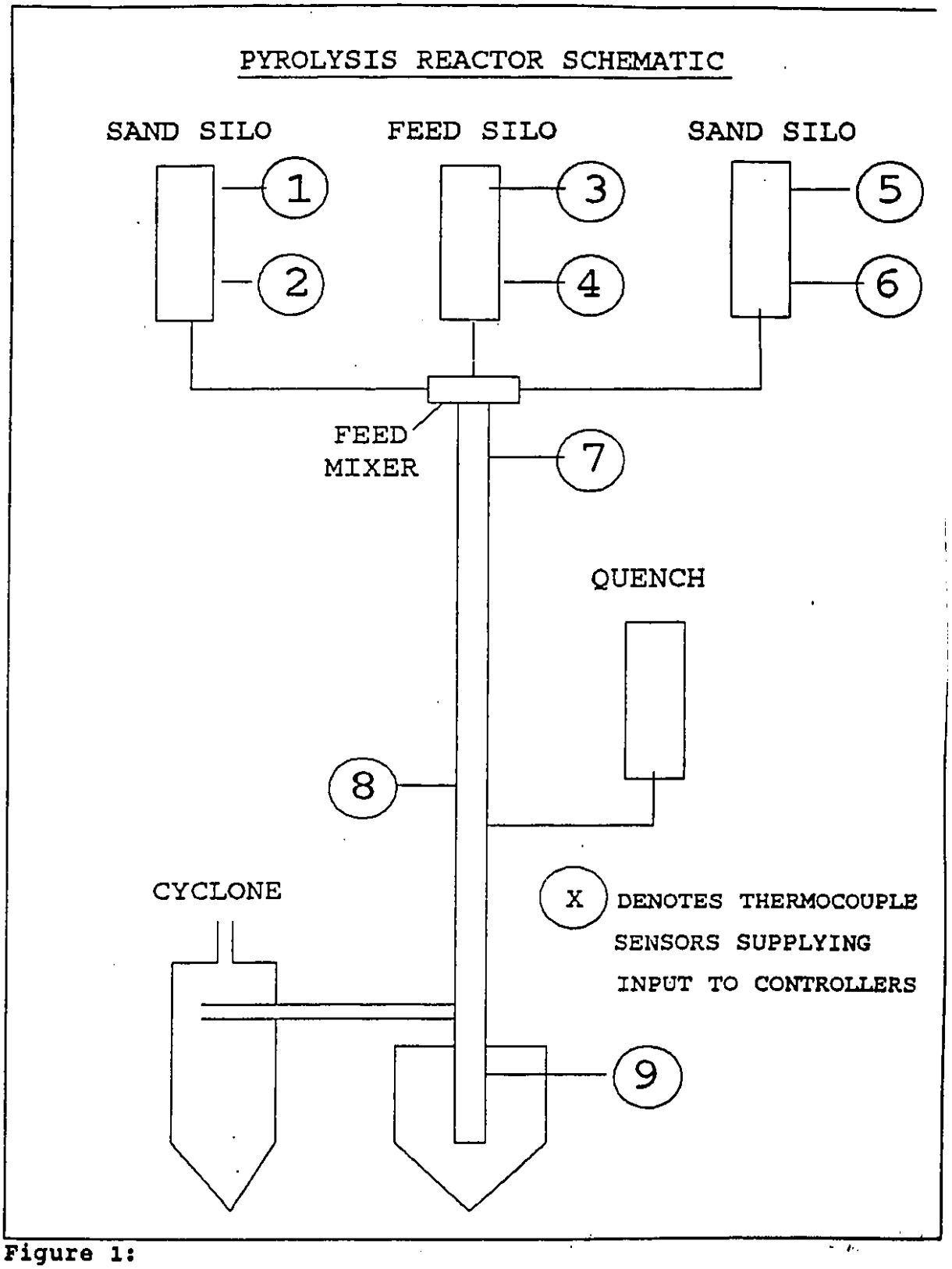
PYROLYSIS REACTOR SCHEMATIC
SAND SILO
FEED SILO
SAND SILO
1
2
3
4
5
6
FEED
MIXER
7
QUENCH
8
CYCLONE
X DENOTES THERMOCOUPLE
SENSORS SUPPLYING
INPUT TO CONTROLLERS
9

Figure 1:

DISCUSSION

Essential Criteria

1. The TCD must be able to process input data from Type J and K thermocouples.
2. The TCD must be able to transmit Solid State Relay (SSR) output to control the heating elements.
3. The TCD must support both On/Off and PID control algorithms.
4. The TCD must have the following programming options; minimum of two setpoints, self-diagnostics and auto-tuning.
5. The TCD must be remote programmable from a personal computer that is equipped with a standard Data Acquisition Board.
6. The TCD must have a minimum of two built-in alarms for high/low temperature warnings.
7. The TCD must exhibit a minimum repeatability of ± 1°C.
8. The TCD temperature and time variables must be programmable with a minimum resolution of 1 second and 1°F/1°C.

DESIRABLE CRITERIA

1. The TCD should have sensor break protection to alert system operators of thermocouple burn-outs or shorts.
2. The TCD should be operable in an environment with ambient temperature not exceeding 50°C.
3. The TCD should support both Fahrenheit and Celsius scales.
4. The TCD should have a digital screen which continuously displays both setpoint and process temperatures.
5. The total system cost (nine devices) should not exceed $4500.

CONTROLLER ALTERNATIVES INVESTIGATED

Controllers are usually grouped into three main classes On/Off, Proportional, and PID. These classes describe the type o controller output (algorithm) used in the manipulation of inpu process variables (e.g. temperature).

On/Off controllers are the simplest devices. The output fro the device is either an "on" or "off" signal. When the proces temperature is below a setpoint, an "on" signal is sent to heater, to supply heat. When above the setpoint, the controlle output is an "off" signal. On/Off control is used when precis control is not required or where the temperature changes are fairl slow. This type of control is most common for high/low temperatur alarm systems. On/Off devices are not especially suited t situations where the temperature frequently crosses the setpoint. In these cases, rapid cycling, or "chattering" of the output fro "on" to "off" may contribute to unnecessary wear on the heaters.

Proportional controllers are used to eliminate the "chattering" problem associated with On/Off control. These devices decrease the amount of power supplied to the heaters as the temperature approaches a setpoint. This prevents overshooting the setpoint, and reduces temperature fluctuations. When the process temperature is outside of a specified range of temperature around the setpoint, the controller switches to On/Off control.

Proportional with Integral and Derivative control, or PID, is used mainly for temperature-sensitive processes, and for processes that require heat to start up, but then generate heat during operation. The PID device combines Proportional control with Integral and Derivative control for adjustments. Integral and

Derivative control allow the controller to compensate for rapid temperature fluctuations by controlling the heaters proportionally to the rate of temperature change.

The controller alternatives studied did not include any purely Proportional devices as they are quite rare, these devices usually include Integral and Derivative adjustment control. The alternatives included both individual and group controllers. An individual controller can monitor only one thermocouple input, whereas group controllers monitor several inputs simultaneously. The following table summarizes the alternatives investigated; all can process input from Type J and K thermocouples, transmit SSR output and can output to recorder equipment.

TABLE 1: CONTROLLER DEVICE ALTERNATIVES STUDIED

MANUFACTURER	MODEL	CONTROL ALGORITHM	TYPE
OMEGA	CN-2001K	ON/OFF, PID	INDIVIDUAL
OMEGA	CN-7100	ON/OFF, PID	INDIVIDUAL
OMEGA	CN-9000	ON/OFF, PID	INDIVIDUAL
FOXBORO	12A	ON/OFF, PID	INDIVIDUAL
WATLOW	810	ON/OFF	INDIVIDUAL
WATLOW	910	ON/OFF	INDIVIDUAL
NANMAC	LT70A	ON/OFF, PID	INDIVIDUAL
BARBER COLMAN	5651	ON/OFF	GROUP (10 INPUTS MAX.)

Should put in separate OPS

A comparison of the above alternatives, based on essential criteria is found in Table 2. Comparison of final alternatives, based on desirable criteria, is found in Table 4.

TABLE 2: ESSENTIAL CRITERIA

MODEL	CONTROL ALGORITHM	PROGRAM OPTIONS	REMOTE PROGRAMMING	ALARMS	REPEATABILITY	RESOLUTION
CN-2001K	ON/OFF, PID	1 SETPOINT	YES	2	±0.55°C	1 SEC 1°F/°C
CN-7100	ON/OFF, PID	2 SETPOINTS A,B	YES	2	±0.2°C	1 SEC 0.1°C
CN-9000	ON/OFF, PID	1 SETPOINT A,B	NONE	1	±0.5°C	1 SEC 0.1°F/°C
12A	ON/OFF, PID	9 SETPOINTS A,B	YES	2	±0.05°C	1 SEC 0.1°F/°C
810	ON/OFF	1 SETPOINT	NONE	1	±0.55°C	1 SEC 1°F/°C
910	ON/OFF, PID	2 SETPOINTS A,B	YES	2	±0.55°C	1 MIN 1°F
LT70A	ON/OFF, PID	1 SETPOINT	NO	NO	±10°C	1 SEC 20°C
5651	ON/OFF 10 CHANNEL	1 SETPOINT PER INPUT	YES	1 PER INPUT	0.28°C	1 SEC 0.1°F/°C

WHERE: Control Algorithm: Must have both On/Off and PID
Program Options: must have two setpoints, A and B options.
A = Auto-Tuning capability.
B = Controller self-diagnostics.
Remote Programming: must be able to communicate with a host computer.
Alarms: High/Low temperature alarms, minimum of two are required.
Repeatability: Accuracy of displaying temperature, must not exceed ±1°C.
Resolution: Minimum scale increments, must not exceed 1 sec and 1°F/°C.

SELECTION OF BEST ALTERNATIVE

This section describes the elimination process used in selection of the best controller alternatives. A final comparison of the most reasonable alternatives will be used to determine the best possible TCD. The elimination process did not consider the input requirements or recorder and SSR output requirements as all alternatives satisfied these criteria. The following table summarizes the elimination process.

TABLE 3: SELECTION SUMMARY

CONTROLLER	PASS?	REASON
OMEGA CN-2001K	NO	ONLY ONE SETPOINT
OMEGA CN-7100	YES	MEETS ALL ESSENTIAL CRITERIA
OMEGA CN-9000	NO	SETPOINTS, ALARMS, REMOTE PROG.
FOXBORO 12A	YES	MEETS ALL ESSENTIAL CRITERIA
WATLOW 810	NO	NO PID CONTROL
WATLOW 910	YES	MEETS ALL ESSENTIAL CRITERIA
NANMAC LT70A	NO	LACKS MOST ESSENTIAL CRITERIA
BARBER COLMAN 5651	NO	NO PID CONTROL, ALARMS, SETPOINTS

Any temperature controller not meeting all specified essential criteria was not considered for final analysis. The models rejected for this reason were the Omega models CN-2001K and CN-9000, the Watlow 810, the Nanmac LT70A and the Barber-Colman 5651.

The temperature controllers meeting all essential criteria were the Omega CN-7100, the Foxboro 12A and the Watlow 910. These devices will be considered for final analysis. This analysis is based on the criteria presented in Table 4 (following page).

The Omega device meets all essential criteria, but special consideration is required in the location of these controllers. This device may not function normally in close proximity to the reactor, as its specified operating temperature range is 0-40°C.

The Foxboro device meets or exceeds every specified essential and desirable criteria. The Foxboro 12A is easily seen as the best performing controller of the three remaining alternatives. This device exceeds most of the specified essential criteria, has better programmability than the other two devices, and excellent resolution and repeatability. However, having these "luxuries" has its price. The total cost of the Foxboro model ($6255) is prohibitive when attempting to meet the desirable criterium of a maximum cost of $4500. This drawback is considered sufficient for the model to be rejected.

Is it really a desirable criteria? Not the way you describe it weak.

The Watlow device has the lowest cost of the three remaining alternatives. Its only drawback may be the lack of °F/°C switching capability.

The Watlow 910 and the OMEGA CN-7100 are two very closely matched controllers when comparing capabilities and cost. The Omega model has a slight advantage in terms of repeatability and resolution. The OMEGA model also has the advantage of having sensor break alarms versus the display warning alarms on the Watlow

TABLE 4: DESIRABLE CRITERIA

MODEL	SBP	AMBIENT TEMP.	°F/°C SWITCH	DISPLAY	REPEATABILITY	RESOLUTION	COST
CN-7100	ALARM	5-40°C	YES	DIGITAL SCD	0.2 °C	1 SEC 0.1 °F/°C	$4185
12A	ALARM	0-50°C	YES	DIGITAL SCD	0.05 °C	1 SEC 0.1 °F/°C	$6255
910	DISPLAY	5-55°C	°F ONLY	DIGITAL SCD	0.55 °C	1 MIN 1 °F	$4095

WHERE: SBP: Sensor Break Protection, for warning of thermocouple failures or other loss of input signal.
Ambient Temp.: Ambient temperature range for normal controller operation, should exceed 50°C.
°F/°C Switch: controller should have variable temperature scales.
Display: SCD: setpoint continuously displayed as well as process temp.
SOD: setpoint displayed on demand only, otherwise shows process temp.
Cost: Total cost for nine controllers, including any options required. to meet specifications.
Note: all costs in canadian currency.

model. The 910 may be better suited than the CN-7100 to the very warm ambient temperatures where the controllers are expected to be installed. Overall, the better repeatability and resolution of the Omega CN-7100, combined with its better sensor break protection, justifies its selection over the Watlow model 910, even at an extra cost of $90.

SOLUTION

The OMEGA CN-7100 is the best available temperature controller device for controlling the process conditions of the pyrolysis reactor. This TCD meets all essential criteria; it offers both On/Off and PID control algorithms, all required programming options (auto-tuning, self-diagnostics, two setpoints), may have remote programming and alarms capability installed at low extra cost, and has good repeatability and resolution characteristics.

The CN-7100 meets the desirable criteria of; sensor break alarms, °F/°C switching, digital display with continuously displayed setpoint and process temperatures, and meets the criteria of not exceeding a total cost of $4500. The CN-7100 only lacks the ability to operate normally in high ambient temperatures.

CONCLUSION

The OMEGA CN-7100 temperature control device is the best available alternative for controlling the process temperatures in the pyrolysis reactor. This controller is recommended as it best meets all primary and secondary criteria. Installing nine of these devices will produce the most reliable performance, required in the operation of an experimental high-temperature reactor. The total cost for nine CN-7100 units is $4185 (Can.).

POTENTIAL PROBLEM ANALYSIS

The selection of the OMEGA CN-7100 device for use in controlling the pyrolysis reactor will allow safe, accurate operation of the high-temperature process. Upon installation of the nine controller units, two steps must be performed to ensure proper use of the controller. First, each unit must be hooked up to its own thermocouple and checked to ensure proper calibration of the device to the sensor input. Second, the process operators must be educated in the use and programming of the devices, and know what the controller will do in emergency situations (shutdown heaters, reset all setpoints, etc.). Due to the low ambient operating temperature range (0-40°C), the CN-7100 will have to be located slightly further from the reactor than the other device alternatives would have required, to ensure proper operation.

A controller may fail during operation of the reactor system, such as loss of input signal from a sensor, or failure of the internal microprocessor, though the latter is highly unlikely. In any case the entire reactor system will have to be shut down to prevent overheating the reactor or feed silos. In the event of sensor failures, the system may not require being shut down if the sensor was located in a low temperature area. However, a high-temperature sensor failure must result in system shutdown.

REFERENCES

1. Barber-Colman Inc., Temperature Controllers, Product Catalogue, 1990.
2. Cole-Parmer Instrument Company, Product Catalogue, Chicago, 1991.
3. Fisher Scientific, Product Catalogue, Toronto, 1991.
4. Omega Engineering Inc., Temperature Handbook, Vol. 27, New York, USA, 1990.

GLOSSARY

Ambient temperature: The temperature of the air surrounding the equipment under operation.

Chatter: The rapid on/off cycling of a relay in a controller due to temperature fluctuations around a setpoint.

Noise reduction: Reduction of unwanted electrical interferences on input signal wires.

Repeatability: The ability of an instrument to give the same reading under repeated identical conditions.

Resolution: Smallest scale increments available.

Setpoint: The temperature at which a controller is set to control a system.

Solid state relays: A relay (switching device) which completes or interrupts a circuit electrically with no moving parts.

Thermocouple: Temperature sensing device, based on voltage generated from junction of two dissimilar metal.

Type J: Iron/Constantan metals, range 0 - 750°C.

Type K: Chromel/Nickel-Chromium, range -200 - 1300°C.

TECHNICAL PAPER II

MOST COMMON MISTAKES

1. Abstract is not well written .
2. Environment of the problem is not well introduced.
3. Problem itself is not well defined and/or poor background section .
4. Criteria of selection are not all listed and/or the rating of the alternatives is based on criteria not provided in the list.
5. Background information on the choice of certain criteria is missing or incomplete.
6. No differentiation between essential criteria('musts') and desirable criteria ('wants').
7. Poor description of alternatives (too long/ too short/unclear).
8. Limited number of alternatives or no first-cut of all possible alternatives.
9. No quick elimination of unacceptable alternatives.
10. One valid alternative only - no possibility for a comparative analysis.
11. Poor development section/ arguments do not progress well.
12. Missing data / arguments not backed up by data.
13. Poor use of graphical language and/or tables.
14. No comparative analysis table summarizing the assessment of acceptable alternatives.
15. Conclusion is not valid or not clear.
16. Conclusion section is not well formatted (part of comparative analysis section, new information provided, etc.).
17. Poor writing style.
18. Poor paragraph and/or sentence structure.
19. Poor grammar and/or use of the english/french language.
20. Report is not well structures.
21. Technical paper is too long / too short.
22. Technical paper uses the wrong format as per course requirements.
23. Paper is late.

University

Department of Chemical Engineering

TECHNICAL PAPER I 302-360 A/B

TECHNICAL PAPER II 302-462 A/B

COURSE INSTRUCTIONS

1991 - 1992

NOTE TO STUDENTS

This document contains essential information for the successful completion of the requirements for Technical Paper I and Technical Paper II. It is the responsibility of each and every student planning to submit a paper in a subsequent semester to read and understand these instructions. Failure to comply with the elements of this document can result in a failing grade on the paper submission.

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University
Department of Chemical Engineering
Technical Paper I & II

Course Instructions
1991 - 1992

1. Why a Course in Technical Report Writing?

The ability to write clear, concise, and accurate technical reports is one of the most important skills that an engineer needs to develop. Unfortunately, insufficient emphasis is placed on writing in most engineering curricula.

Engineers start their careers in industry and usually experience varying degrees of "culture shock" when confronted with the task of writing a technical report for their particular organization. No longer is the traditional descriptive "lab report" sufficient to meet the needs of their employer. Furthermore, the young engineer is summarily required to justify, validate, defend, and "sell" his solution, rather than merely present what he feels is the best. The true essence of engineering, that of vision, global conceptualization, compromise, and defensible arguments emerges and becomes as important as the calculations themselves.

There are many formats and styles that a technical report can take, and it is always preferable to determine that which one's particular organization requires. This course presents a methodology for one of the more frequently used types of report, that of a structured analysis of alternatives.

2. Objectives of the Course

The objectives of both courses are identical, as are the instructions. The prerequisite for Technical Paper II is successful and satisfactory completion of the requirements for Technical Paper I.

Students are expected to apply what they have learned in Technical Paper I in the preparation of Technical Paper II. Accordingly, the grading of Technical Paper II is considerably more severe.

The principal objectives are to give the student an opportunity:

a) to make an independent investigation of a technical topic,

b) to analyze this topic critically,

c) to learn to communicate the results of this investigation in an effective written form, and;

d) to respond to a critical review of the paper by discussing with the reviewer areas where improvements are needed and revising the paper accordingly.

3. General Procedure and Grading

Ideally, technical papers are prepared during the summer, based on a topic selected from a summer job experience or from other sources. Please note that there is considerable latitude and flexibility in the choice of topics, but the subject must be of a technical nature.

The time spent in preparation of this report should reflect that which is expected in any other one-credit course, i.e. a minimum of 40 hours is required to produce an effective job. It is highly recommended that this time be spread out over several weeks to permit the development of a quality report. Generally speaking, a hasty effort at the last minute is more than obvious in the final product.

Students have the option of submitting the paper either in the Fall or Winter semester. It is strongly recommended not to leave Technical Paper II until the semester when you expect to graduate. Contrary to popular belief, grading standards are high and a passing mark is not "guaranteed". Furthermore, no special allowances will be made for students in this position.

The first submission of the paper is due early in the term. It is graded and in most cases the need for revision is established. Following a conference with the professor in charge, the paper is revised and resubmitted. The revision may result in an improvement in the grade over that given on the first submission.

The grading system is as follows:

The first submission will receive a tentative grade of A, B, D, or F with revision being mandatory for D and F papers. Revision is optional for A or B papers.

Late submissions will not be accepted.

Students who make their first submission on the date of the second submission (i.e. students who do not make a first submission with the rest of the other students) will receive a final grade of F.

As stated above, D and F papers require revision. Only one such revision is permitted. Please note that for a revision to be accepted, it must properly address all the items/issues noted by the professor who marked the paper in the first place. The grade of D or F will be maintained if no significant improvement is made.

4. Submission of the Technical Paper

The following submission schedule has been established for 1991 - 1992. It must be strictly adhered to as no special arrangements will be made to accommodate late submissions.

Submission Schedule For 1991 - 1992

Fall Semester

Deadline for first submission	September 16, 1991
Return of papers	October 15, 1991
Deadline for revision	November 4, 1991
Return of revised papers	November 18, 1991

Winter Semester

Deadline for first submission	January 13, 1992
Return of papers	February 10, 1992
Deadline for revision	March 2, 1992
Return of revised papers	March 16, 1992

5. Grading Criteria

Your technical paper will be evaluated according to the following criteria:

(a) Conformity to Course Objectives

This criterion is evaluated as a "go / no go " decision. The reviewer will look at whether or not the submission has the required elements of a technical paper - problem statement, context of the problem, selection criteria, alternatives, analysis, conclusion, recommendation, potential problem analysis - as well as the appropriate style - problem solving format versus lab report. The reviewer will also look at the originality of the topic and the approach as well as whether the paper provides a critical analysis of a practical problem.

(b) Statement of the Problem

This criterion is evaluated on the basis of the writer's ability to select a particular significant problem which is limited in scope, and after a well-structured and concise introduction, to define it clearly. The writer must demonstrate a good overall grasp of the situation, establish the necessary hypotheses and provide a meaningful set of well-defined essential and desirable selection criteria, which will be used to evaluate the alternative courses of action.

(c) Development of the Solution

This criterion is assessed on the writer's ability to screen the chosen alternatives against the given set of essential criteria, and then, based on a go / no go decision process, to select at least two acceptable alternatives for further analysis. Following this, the writer will progressively and logically funnel the remaining valid alternatives down to one clear choice using strong, verifiable, and selective arguments.

(d) Decision / Recommendation

For this criterion, the writer is evaluated on the effectiveness of his recommendations. They should flow effortlessly from the preceding analysis, be precise, concise, and verifiable. The writer should be ready and able to defend them against all criticism.

(e) Technical Content

This criterion assesses the technical background of the paper, its soundness, objectivity, and relevance to the real world. The use of numbers, specifically the pertinence, accuracy, and development of technical calculations is also evaluated. The use of figures, graphs, or diagrams, their presentation and relevance are also evaluated.

(f) Presentation, Style, and Phraseology

This criterion evaluates the coherence, objectivity, verifiability, and non-repetitiveness of the report. The writer is expected to demonstrate good working knowledge of the reporting language and to edit his report carefully.

The report must be concise and show a good progression of ideas from topic to topic.

Also of concern is the ability of the writer to show a good choice and usage of words, provide well-structured paragraphs and sentences, and observe the basic rules of English grammar and spelling.

The reviewer will also assess the organization and structure of the paper, and evaluate the effectiveness of the abstract.

Definition of Grades

Final grades may be largely interpreted as follows:

A:	EXCELLENT	Could be presented as-is in a business situation. At worst, only minor style and phraseology corrections are needed. It presents a two-step progression towards a solution: a go / no go selection to arrive at final acceptable alternatives, then a comparative analysis of these alternatives to arrive at the best one.
B:	GOOD	Although lacking in some fine points, this paper is reasonably well-done. It would require some polishing before being presented in a practical business situation. The report does not have major flaws in any of the grading criteria.
C:	FAIR	This paper lacks logic, organization, clarity, conciseness, or fails to get to the point. It could not be presented as-is and needs considerable reworking.
D:	POOR	This paper is totally deficient in all the above and in addition is unconvincing, poorly presented, messy, or verbose.
F:	UNSATISFACTORY	This paper should not have been submitted. Spelling, grammar, and syntax are poor. It could be that insufficient effort or thought has gone into its preparation, or that the writer omitted to attend the Effective Technical Writing seminar, where important information about writing the report is given out.

6. Topics

"Engineers are problem solvers", therefore ANY ENGINEERING REPORT MUST BE CONCERNED WITH SOLVING SOME PRACTICAL PROBLEM.

The problem itself must be clearly defined and the factors considered in the solution concisely presented in a manner which develops the conclusions logically. This leaves a great deal of latitude but it specifically rules out descriptions of processes and even extensive engineering calculations on a process if there is no issue of practical importance involved.

Generally, the technical report should be written to convince the reader that there is a situation which requires attention, to develop for him some ways to deal with the situation, and to recommend the best course of action.

The treatment of your subject must be at a level appropriate to your background. I.e. you are expected to apply material you have been exposed to in other courses when appropriate.

Furthermore, it is expected that spelling, grammar, and syntax will be commensurate with a university-level course.

The following suggestions may be useful:

(a) The best topics arise as a result of summer work experience. Ideally, you will see some aspect of your job or the process you are dealing with that could be improved, and you will write a report on the situation, the need, and the recommended action.

(b) DO NOT USE material from a previous paper, project, or course. Trying to "kill two birds with one stone" rarely achieves the objectives set out for this course.

(c) If you have no relevant summer work experience, topics can be generated by reviewing the literature for a subject of personal interest. Don't lose sight of the need to be practicall Seek out the most recent references and research your topic until you are familiar enough with it to write about it authoritatively and intelligently.

AVOID SELECTING A LAB PROJECT as past tendencies have been to produce a lab report - which is not acceptable. Remember that you are trying to solve a PRACTICAL problem.

Furthermore, a DESIGN PROJECT which systematically runs through masses of calculations is totally unacceptable.

(d) If you are in doubt about the topic you have selected, it is advisable to contact the professor in charge and discuss your choice with him ahead of time. The names, addresses, and phone numbers of these individuals are included at the end of this document.

A WORD OF WARNING: Please note that plagiarism is difficult to cover up and such a paper will automatically and irrevocably receive a final grade of F. In such a case, the situation will be reported to the Department Administration, and appropriate action will be taken.

7. For Whom Do You Write Your Technical Paper?

Your only real reader will be the professor in charge of the course, so you should present the material at a level and in a style which will hold his interest.

Both professors are graduate chemical engineers who also hold advanced degrees in Business Administration and who have been employed in industry for over eighteen years.

To help organize your presentation, it may be useful to pretend you are trying to convince your superior, who is an overworked executive, to act on your recommendations. You should take into consideration how he will read your paper:

Generally, he will read it on three different levels:

(a) the abstract

(b) the introduction, conclusions, and recommendations

(c) the entire paper

You must write in such a manner as to entice him to read the paper at all three levels. This is not done by building up suspense about the purpose of your paper (the mystery novel approach). On the contrary, you should be as informative as possible about the objectives and the conclusions / recommendations of your paper at all levels, varying only the detail of reporting from a very concise synopsis in the abstract to a full discussion of all relevant material in the body of the report.

The style must be suitable for a professional paper. It should be balanced between casual and excessively profound. I.e. it must be readable, but remain technical.

Will the paper hold the reader's attention? Lists of points, chit-chat approach, and extensive tables will not.

Try reading your paper to a friend - if he is still your friend afterwards then the style may be acceptable.

Grammar, spelling, syntax, and other basic language requirements MUST be 100% correct. If English is not your mother tongue, make sure someone who is fluent proofreads your paper prior to submission. Poor language quality reports are unacceptable and in extreme cases will be returned unmarked.

8. Format

The length of the paper should be limited to 2500 words of text. This represents approximately 10 typewritten pages. Although some latitude in report length is acceptable, excessively long papers will be returned unmarked. Similarly, exceptionally short papers (less than 1500 words of text) usually indicate insufficient effort and warrant lower grades.

The length limit does not apply to detailed calculations or background information which should be appended, but will be applied if the contents of the appendix are necessary to follow the analysis in the main body of the report.

Papers must be typewritten, double-spaced, on one side only of 8½ x 11 inch white paper of good quality. The margin must be at least 1½ inches on the left side of the page. The paper must be enclosed in a black ACCOPRESS binder (Type 2507) or an equivalent.

Illustrations should be used wherever they will help to clarify your arguments; flowsheets of processes and drawings of equipment can also be included if they are relevant. Do not use illustrations simply as decoration. If the illustration is not specifically referred to in the text, DO NOT include it.

Drawings and graphs must be prepared carefully and neatly. Titles, legends, numbers, etc. should be printed or typed. The use of Letraset transfer characters (or an equivalent) is recommended to provide a more professional appearance. Computer-generated graphics may provide a higher degree of professionalism but please ensure they are of the highest quality. If your printer ribbon is wearing out, please invest in a new one before running your print job.

The following outline should be followed unless there are special reasons for modifying it:

TITLE - should be chosen with care to indicate as specifically as possible the content of the paper. KEEP IT SHORT.

ABSTRACT - a capsule version of your paper, stating objectives, methods of solution, conclusions and recommendations of your paper as concisely as possible (50 -150 words maximum).

YOU MUST SUBMIT A SEPARATE COPY OF YOUR ABSTRACT WITH THE PAPER'S TITLE, YOUR NAME, STUDENT NUMBER AND DATE, ALONG WITH YOUR FIRST SUBMISSION.

ACKNOWLEDGEMENT - should briefly indicate if this work was the result of a summer job. Where? What company? What were your duties? Who helped you with the material? Etc.

TABLE OF CONTENTS - should list the major headings and sub-headings with page numbers. Avoid too-extensive a breakdown.

LIST OF ILLUSTRATIONS - should list all illustrations with page numbers.

INTRODUCTION - must include a clear statement of the problem as well as the objectives of the paper. It may also include an outline of relevant background to the specific topic.

BACKGROUND - A separate background section may be used but only if preliminary information is included which is essential to understanding the paper. If you are uncertain whether the reader will understand your background information and want to write more explanatory or descriptive material, this should be placed in an appendix.

DISCUSSION - must present a logical progression of analysis to lead the reader from the problem statement to the conclusion. This section should be subdivided into the required and appropriate headings such as:

Method of Analysis
Criteria of Selection
Alternatives
Analysis of Alternatives
Results
Assumptions Made (and their limitations)
Etc.

CONCLUSION AND RECOMMENDATIONS - must present an answer to the problem stated in the introduction. Together, the introduction and conclusion should make sense without the rest of the paper. The conclusion may also include additional findings which you did not

seek at the outset, but which resulted from the analysis nonetheless. Please be sure, however, to not introduce new information, such as new selection criteria, at this point.

Be sure that you recommend a course of action. Be firm and positive. Don't leave it up to the reader to try to figure it out. You must also perform a "POTENTIAL PROBLEM ANALYSIS" on your final solution to determine what weaknesses are inherent and what could be done if any of your assumptions turned out not to be true. In other words, determine what could go wrong with your solution and if it did, what would you do about it.

REFERENCES - Every reference from which the information in your paper was obtained must be specifically referred to in your paper and listed at the end of your paper in alphabetical order or in order of first mention.

Each reference must consist of the authors' names, title of the paper or book, name of the journal, volume, number, pages, publisher of the book, and year of publication. Look up any standard journal for acceptable formats. Material transferred directly from any reference must be presented in your text in the form of a quotation.

FIGURES AND TABLES - should be used when they will help to clarify, illustrate, or summarize pertinent information. All figures and tables must be specifically referred to and fully discussed in your text. This is particularly true when discussing processes or equipment where it may be useful at the beginning of your discussion to refer to the flowsheets or drawings.

APPENDICES - Use them sparingly, and only if needed.

9. Revisions

The majority of papers require some sort of revision. Please remember that the criticisms come from qualified people who have read your paper carefully. Points that seem awkward or unclear to them will likely have the same effect on others.

In order to reduce the work required when revision is necessary, some prior planning can help:

(a) Place your figures and tables on separate, text-free pages, so that these will not require retyping if only the text is to be revised.

(b) make a photocopy of your paper before you submit it, BUT PLEASE SUBMIT YOUR ORIGINAL. If it is worth writing in the first place, it is worth submitting your original copy. The marker will make only limited written remarks in light pencil on the paper itself. An individual comment sheet will be provided to each student.

This applies to both submissions and will provide insurance in the unlikely event of the paper being lost or misplaced.

(c) Typing the paper with the use of a word processor is by far the best and most efficient way to ensure that a minimum of work will be required upon revision. Please make sure that the print quality is letter-grade.

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WHEN YOU SUBMIT A REVISION, YOU MUST ALSO SUBMIT THE MARKED-UP PREVIOUS SUBMISSION (OR A PHOTOCOPY) SO THAT THE MARKER CAN COMPARE HIS CRITICISMS WITH YOUR CHANGES. Revisions submitted without the prior marked-up version will not be read.

If a student submits a paper in the Fall semester, then withdraws from the course and re-enrols in the Winter or any subsequent semester, the original marked-up paper must be submitted with the new one.

10. Possible Approaches to Paper Preparation

(a) Select a topic that interests you (as far in advance of the due date as possible).

(b) Research your topic as time permits (leaving sufficient time to do the writing).

(c) Begin the paper preparation by making rough notes on your topic, such as: a list of the most important ideas, theories, pieces of equipment, etc.

(d) Select a small number of points which are the ones you want to convey to the reader. These may be seen as conclusions and recommendations, or they may represent your idea of what is really important to the subject.

(e) Prepare the figures and tables you will use to guide the reader to the conclusions determined in step (d).

(f) Make a rough outline of the paper which must introduce the reader to the subject, develop the necessary material to lead to the conclusion, and present the conclusion.

(g) Look for points in your outline where the reader (or you) might get confused, and revise or expand the outline to cover these problems. Your own classmates may be able to help you with this.

(h) Now, write the first draft of your paper.

(i) Let is sit for a few days before you read, revise, and smooth out your paper.

(j) Write an abstract which, in about five sentences, summarizes your paper (including the introduction and conclusions).

(k) If possible, have someone read your paper critically. Then make any final revisions.

(l) Verify that all the elements required are present, and that all the terms of these instructions have been complied with.

(m) Type up the paper, PROOFREAD, and correct errors in the text as well as the figures, and then make a copy for your retention.

11. Effective Technical Writing Seminar

This one-evening class is compulsory for all students registering in 302-360 A or 302-360 B (Technical Paper I). It will be given in early November and early March. More details will be made available in October and February.

12. Further Information

Technical Paper I

Technical Paper II

APPENDIX C
COMMENT SHEET

UNIVERSITY

FACULTY OF ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

302-360A/B AND 302-462A/B

TECHNICAL PAPERS I AND II

INDIVIDUAL COMMENT SHEET

STUDENT NAME: _____

STUDENT NUMBER: _____

PAPER TITLE: _____

TENTATIVE GRADE: A B D F

FINAL GRADE: A A^- B^+ B B^- C^+ C D F

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1. CONFORMITY TO THE COURSE OBJECTIVES

0 5 10

POOR ADEQUATE GOO

a) Does the report have the elements of a technical paper?
b) Does it follow the format of the course?
c) Is the topic original?
d) Does it provide a critical analysis of a particular problem?
e) Is the paper unduly long? short?

2. STATEMENT OF PROBLEM

0 5 10

POOR ADEQUATE GOO

a) Is the introduction concise and well-structured?
b) Are the objectives of the analysis clearly defined?
c) Are the significant aspects of the problem considered?
d) Are all the criteria of section listed and well-defined?
e) Is there a clear distinction between desirable and essential criteria?
f) Are the hypotheses surrounding the problem well-stated?

3. DEVELOPMENT

0 5 10

POOR ADEQUATE GOO

a) Have all the alternate courses of action been considered?
b) Are the alernatives defined adequately? (length, structure, format)
c) Is there differentiation among fact, opinion and assumption?
d) Have ideas been worked with so that arguments develop and progress?
e) Are the arguments supported with evidence or fact?
f) Is an appropriate comparative analysis table provided?

4. DECISION/RECOMMENDATIONS

0 — 5 — 10
POOR — ADEQUATE — GOOD

a) Has a definite and convincing decision been reached?
b) Is the chosen alternative drawn from a group of at least 2 acceptable solutions?
c) Does the decision follow from the analysis?
d) Have unrealistic conclusions from the analysis been avoided?
e) Have all the important effects of the recommended action been considered?
f) Is the format of the conclusion and recommendation section correct?

5. TECHNICAL CONTENT

0 — 5 — 10
POOR — ADEQUATE — GOOD

a) Does the solution of the problem have a sound technical background?
b) Is the technical development of the solution objective?
c) Is the data ethical, verifiable, reliable and accurate?
d) Are the calculations pertinent?
e) Are the calculations accurate in method and arithmetic?
f) Are the results of these calculations tied in with the text?
g) Is the use of graphical language and tables effective and its basis/contents well-balanced?
h) Is the Appendix section well-utilized?

6. PRESENTATION, STYLE AND PHRASEOLOGY

0 — 5 — 10
POOR — ADEQUATE — GOOD

a) Is the abstract effective?
b) Is the report well-structured?
c) Are the presentation and typing neat and legible?
d) Have rehash, irrelevance, generalization and other methods of "space wasting" been avoided?
e) Does the report refrain from being verbose and cumbersome?
f) Is the report clear and easy to read?
g) Does the writer show a good choice and usage of words?
h) Are the paragraphs and sentences well-structured?
i) Are the basic rules of grammar observed?

7. SUMMARY APPRAISAL