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Exigencies for engaging undergraduates in rhetorical problem solving : insights from engineering managers and A3 report analyses

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EXIGENCIES FOR ENGAGING UNDERGRADUATES IN RHETORICAL PROBLEM SOLVING

INSIGHTS FROM ENGINEERING MANAGERS AND A3 REPORT ANALYSES

By

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This thesis, "Exigencies for Engaging Undergraduates in Rhetorical Problem Solving: Insights from Engineering Managers and A3 Report Analyses," is hereby approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE IN RHETORIC AND TECHNICAL COMMUNICATION.

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For Jimmy and James

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When a project encompasses young people, educators, and workplaces, I find that my acknowledgements cannot be bound within merely my three years in graduate school. I begin by extending thanks to my parents, Raymond Straw and Sylvia Straw, who advised me to see problems as opportunities and to embrace them with persistence and resourcefulness. Through my research with managers, I have discovered that these ideals are essential, but not intuitive, for meeting everyday workplace and disciplinary problem-solving challenges. For this reason, I can say with sincerity that my parents have provided me with the impetus for this thesis work.

The origin of my thesis topic was in 2004, well before I began graduate studies. My husband, Jimmy, and I had been looking for learning opportunities to engage our 9-year old son, James, a budding-scientist and explorer. We discovered FIRST LEGO Robotics and Robofest, which are problem-based research and design competitions for young people. Jimmy and I formed the Masterminds Robotics Team, and over the course of five years guided 21 team members through twelve competitions. Time and time again, the Masterminds courageously stepped out of their comfort zones to research, collaborate, discuss ideas with scientists and engineers, as well as convince competition judges that their ideas were superior. Throughout my graduate studies, I often reflected upon these problem-based learning experiences, which

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In order to identify strategies to help undergraduates prepare for workplace problem solving, I needed to gain a better understanding of workplace practice and sought the assistance of three managers. I would like to acknowledge the extensive contributions of the engineering

managers who unselfishly participated as research subjects in this thesis research. Although these managers remain anonymous in this work, I am very grateful to them. These managers' insights into workplace problem solving and decision making as well as their suggestions for preparing undergraduates for workplace practice essentially formed the basis of this thesis. In particular, I wish to extend my sincerest thanks to the engineering manager who provided engineering reports for analysis, who spent much time guiding me through the interpretation of these rhetorical artifacts, and who helped me discover the exigency and realize the potential of this research. All three managers who participated in my study were very generous with their time and enhanced my research and my message in ways that I can never repay; I thank you.

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"the R-word." Both Jimmy and James have been eager contributors, and their perspectives have been invaluable to me. Finally, I wish to acknowledge my husband Jim with much affection; he has been my pillar, my confidant and my best friend, and I thank him.

Abstract

Undergraduate education has a historical tradition of preparing students to meet the problem-solving challenges they will encounter in work, civic, and personal contexts. This thesis research was conducted to study the role of rhetoric in engineering problem solving and decision making and to pose pedagogical strategies for preparing undergraduate students for workplace problem solving. Exploratory interviews with engineering managers as well as the heuristic analyses of engineering A3 project planning reports suggest that Aristotelian rhetorical principles are critical to the engineer's success: Engineers must ascertain the rhetorical situation surrounding engineering problems; apply and adapt invention heuristics to conduct inquiry; draw from their investigation to find innovative solutions; and influence decision making by navigating workplace decision-making systems and audiences using rhetorically constructed discourse.

To prepare undergraduates for workplace problem solving, university educators are challenged to help undergraduates understand the exigence and realize the kairotic potential inherent in rhetorical problem solving. This thesis offers pedagogical strategies that focus on mentoring learning communities in problem-posing experiences that are situated in many disciplinary, work, and civic contexts. Undergraduates build a flexible rhetorical *techné* for problem solving as they navigate the nuances of relevant problem-solving systems through the lens of rhetorical practice.

Chapter 1

Introduction

This thesis report is the culmination of my journey as a graduate student in the Rhetoric and Technical Communication (RTC) program at my university. The term "rhetoric" meant little to me when I first began the program. Yet, my exploration with fellow graduate students over subsequent semesters led me to understand that "rhetoric" refers to both the situated inquiry used to solve problems as well as the persuasive messages that come from this inquiry. I became aware that many people misunderstand "persuasion" and "rhetoric" as the unethical and self-serving practice of manipulating public opinion. Yet, early philosophers and rhetoricians, such as Aristotle, condemned such notions of “rhetoric,” instead defining rhetoric as a service that facilitates decision making towards future action (Bizzell & Herzberg, 2001, p. 145). This definition positions rhetoric as noble, where rhetorical messages are used to help the audience make the best possible decisions.

I came to understand that the delivery of rhetorically persuasive messages is not limited to written or oratorical forms, as classical philosophers suggested. Instead, we can consider any expressed juxtaposition of symbols, images, text, or action as rhetorical acts and artifacts when it is intended to influence action. I learned how rhetorical messages, cultural meanings, and the politics of technologies intersect to influence the attitudes, actions, and opportunities of people. I considered the rhetorics of technology and consumer-based industries, which work to direct action and attitudes that both empower and deny. I explored the rhetorics of science and of academic disciplines, which are intended to advance knowledge by inspiring learners and by influencing disciplinary communities and institutions to accept new ideas. I discussed how the

rhetorics of academic disciplines often conflict with the rhetorics of American universities, which work to attract students-as-consumers, shopping for career preparation among university programs.

My instructors invited my fellow graduate students and me to engage in virtual and classroom environments. These classrooms became safe contact zones, which Pratt (1999) describes as "social and intellectual spaces where groups can constitute themselves as horizontal, homogeneous, sovereign communities with high degrees of trust, shared understandings, temporary protection from legacies of oppression" (p. 6). In our online and classroom discussions, we were encouraged to reflect, critique, contextualize, and reconcile the informed perspectives we studied from multiple disciplinary communities. I learned how different perspectives must be considered to reach meaningful understanding and that each person's understanding will always be unique. I drew from varied domain-specific interests, disciplinary expertise and work experience to understand the topics posed in graduate classes.

Preparation for Workplace Success: Problem Solving with an Engineering Focus

My own education, problem-solving work and life experience have strongly influenced my understanding of academic research as well as my understanding of workplace success. My undergraduate degree in Scientific and Technical Communication included a technical focus in Mechanical Engineering. This educational background, my experience working in manufacturing workplaces as well as my experience coaching youth in science and robotics competitions offered inspiration and efficiencies for my analysis. When I read articles about rhetoric, cultures, and technology, I thought about the ways in which managers, technical writers, and engineers used rhetoric to solve problems in the manufacturing and training environments where I had worked.

From my perspective, my workplace success depended on my ability to solve problems and to persuade others to implement my ideas. Many scholars I studied considered solving problems and communication as valued skills in today's globalized and computerized workplaces. For example, Frank Levy and Richard Murname argue that university graduates will need to have "the ability to bring facts and relationships to bear in problem solving, the ability to judge when one problem-solving strategy is not working and another should be tried, and the ability to engage in complex communication with others" (p. 6). Other scholars considered skills necessary for complex information and data environments. Technical communication scholar Johnson-Eilola (2005) argues in his book, *Datacloud*, that workers will become symbolic-analytic rhetoricians who need "to communicate rapidly and in multiple media, to organize and circulate information, and to attack problems in creative, non-traditional ways" (p. 19 & 31-32). From this research, I began to consider how educators could provide learner-focused opportunities to help undergraduates develop such problem-solving and rhetorical skills.

FIRST LEGO League Challenges: A Pedagogical Approach for Building Skills in Problem Solving

Throughout my graduate studies, I often reflected on my experience co-coaching teams of 9 to 14 year old students for FIRST (For Inspiration and Recognition in Science and Technology) research and robotics competitions, where young people worked together to solve real problems and persuade judges. As a coach, I saw how FIRST LEGO League (FLL) approaches inspired young people like our undergraduates to engage in networked, critical, and innovative thinking.

FLL was and is impressive. Since its inception, over 20,000 FLL teams from 61 countries have worked together to "research, build, and experiment, and by doing so, they (have lived) the entire process of creating ideas, solving problems, and overcoming obstacles, while gaining

confidence in their abilities to positively use technology." (FLL, 2005, http://www.firstlegoleague.org). These FLL teams exemplified communities of practice, where members learned and worked together to meet each year's robot game challenge and exploratory research challenge. Each year's research challenge prompted teams to explore a sphere of activity (or domain), understand the rhetorical situation to identify the problem and constraints, and apply a rubric to form an investigative plan. Once investigation was conducted, and a solution was selected, the teams would design a presentation strategy (with the competition rubrics as a guide) intended to convince judges to understand the significance of the research problem and the merit of their solution. Team skits, display materials and presentations worked together and rhetorically to communicate the logos (logic), pathos (emotional appeal), and ethos (credibility) of their work. FLL challenges encouraged exploration of science, engineering, cultures, and society that inspired students to take an active role in advancing knowledge and making the world a better place.

Importance of Helping Undergraduates Prepare for Workplace Problem Solving

Since my first days in the RTC program, I have considered assigned academic publications in the context of engineering problem solving, a domain that allowed me to explore all aspects of the rhetoric-culture-technology intersection. The domain of engineering seemed ideal because engineers receive problem assignments, where they are expected to propose a solution to the specific problem. As I continued in the RTC program and began my thesis project, I came to realize that, to be successful problem solvers in the workplace, engineers must conduct their project assignments by embodying rhetorical practices. Engineers must consider the rhetorical situation (urgency, decision-making audience, and constraints). Engineers must conduct a rhetorical investigation by using the appropriate cultural, disciplinary, and problem-

specific heuristic (means of inquiry and investigation) to identify an ideal solution. In addition, engineers must provide the decision-making audience with necessary information and the proposed solution to address an assigned problem and support the aims of the workplace. When accepted, the engineer's solution often leads to the manufacture of tangible objects.

Many of my fellow grad students taught undergraduate-level composition to sophomore students, whose focus of study was often a science or engineering discipline. Those who taught composition courses shared their challenges in teaching rhetorical practices to undergraduates, who seemed to consider rhetorical practice as irrelevant to their goals. Ironically, as empowered consumers, these undergraduates delivered rhetorical messages through teacher evaluations that captured the educator's attention and influenced the pedagogical practices employed. We also discussed how society expects educators to prepare students for the personal, civic, and workplace challenges they will encounter in the future.

Since FLL had established a pedagogical model for inspiring young people to engage and succeed in rhetorical problem solving, I began to consider pedagogical approaches to help prepare university undergraduates for solving the disciplinary-specific problems they will encounter in the workplace. In particular, I was intent on finding pedagogical approaches that could provide a bridge between the undergraduates' culturally influenced approaches to thinking, learning, and problem solving in a variety of disciplinary contexts and the knowledge, skills, and abilities needed for workplace problem solving. To identify these suitable opportunities and pedagogical approaches for undergraduates, I needed a better understanding of workplace practice and undergraduates' attitudes towards problem solving, heuristics, integrated technologies, and learning communities.

Chapter Overview

The purpose of this thesis is to explore how universities, and educators in particular, might help undergraduates prepare for the problem-solving experiences they will encounter during their careers after graduation. I report my research findings in respect to the intersection of rhetoric, culture, and technology in workplace problem-solving contexts and to propose suggestions for university educators that are intended to inspire and guide undergraduates in the *technê* and *praxis* of rhetorical problem solving as preparation for workplace practice. While the focus of this research will examine the workplace learning and problem-solving practices of engineers, I believe that my suggestions are appropriate for undergraduate education in any discipline.

In Chapter 1, I convey the exigency of helping undergraduates develop their expertise in solving rhetorical problems like those they will encounter in the future. I frame this research by providing a brief overview of how my experience has inspired my interest in this research topic to understand workplace problem solving and pose pedagogical approaches intended to help undergraduates prepare for workplace problem solving.

In Chapter 2, I develop a review of literature exploring rhetoric in the context of problem-solving practice and engineering workplace communication. In addition, I review research that suggests how the new undergraduate's indoctrination into problem-solving practice has been highly influenced by consumer-based industries, technologies, Internet culture, and school. Finally, I review current and emerging pedagogical approaches used to develop the undergraduate's skills in rhetorical problem solving. I demonstrate how understanding workplace practice and guiding undergraduates in preparing for these practices is an exigent deliberative problem for educators and curriculum planners. In addition, I propose a workplace study to better

understand workplace practice and suggest pedagogical approaches that can help educators address this exigency.

In Chapter 3, I describe the research methodology and mixed methods approach used for this thesis to examine the intersection of rhetoric, culture, and technology in the context of the engineering workplace. My methodology includes workplace research, conducted through interviews with three engineering managers: a manager from an automotive company, a manager from a household-products manufacturing company as well as a manager who works with entrepreneurial and new venture companies. In addition, my methodology includes the heuristic analysis of brief, form-style A3 reports, which are often used and customized by organizations engaged in manufacturing and other businesses to present project plans and findings.

In Chapter 4, I provide a summary of my analysis of two engineering artifacts. This review reflects a limited exploratory study, consisting of the side-by-side heuristic analysis of two engineers' A3 project planning reports with the interpretive assistance of their manager. To support this analysis, I include the views of three engineering managers to clarify how rhetorical principles are critical to the engineer's success and how new engineers learn these practices.

In Chapter 5, I propose pedagogical changes that best prepare undergraduates for workplace problem solving. These pedagogical approaches are meant to inspire university educators to surmount student expectations of surface learning by rearticulating pedagogical practices and by fostering collaborative learning relationships in ways that help undergraduates realize the exigency and engage in the *praxis* of rhetorical problem solving.

In Chapter 6, I conclude this thesis by suggesting next steps for universities, and educators in particular, for addressing this thesis' deliberative problem topic, which is to help undergraduates prepare for the deliberative, rhetorical problem challenges they will encounter in workplaces after graduation. This chapter includes a final analysis of this thesis project as well as a heuristic for educators that can be used to investigate and implement the pedagogical

approaches I suggest in Chapter 5. This heuristic prompts educators to better understand the rhetorical situation, especially in understanding the experiences, expectations, and needs of both their students and the workplaces where these students will be employed after graduation.

My intention in this thesis is to illustrate the exigency of rhetorical problem solving within undergraduate curricula and to pose pedagogical approaches for educators who wish to help undergraduates prepare for workplace problem solving. The pedagogical approaches considered in this thesis are meant to support undergraduates in building expertise, in both domain knowledge and rhetorical problem solving, that will enable them to play an active role in today's globalized or local multicultural learning and working environments.

Chapter 2

Literature Review

My challenge in this thesis is to suggest pedagogical strategies for universities, particularly educators and curriculum planners, to prepare undergraduates for workplace problem solving. Universities, known for fostering discipline-specific expertise, may consider understanding the multi-faceted and multi-disciplinary requirements of workplace practice to be an ill-suited priority. Yet, since I was an undergraduate in the mid-1980s, university education has become more responsive to the needs of both student and workplace.

I became aware of this shift back in March 1993 when I was handed an article from PRISM magazine, the journal published by the American Society of Engineering Educators. In the article, Jeff Meade (1993) had proposed the use of customer-focused, Total Quality Management (TQM) principles in higher education as a way to prepare business and engineering students for workplace practice as well as a way to make universities more effective and efficient (p. 25). William Edward Demmings, who is credited for establishing concepts that later became TQM, had successfully implemented his ideas in several Japanese businesses, which were hungry to provide products that customers would buy, establish reputations for quality and reduce costs through efficiency.

Since the 1990s, TQM and many Japanese business practices have been adopted with fervor as exemplary models by industries around the globe. As part of TQM, organizations identify both internal customers, which I define as workplace system-users, as well as external customers, which would include potential consumers of products and services as well as society, who would be influenced by products and services. These organizations implement strategies to

understand the needs, perspectives, and opinions of these customers and to implement other TQM philosophies, such as continuous quality improvement and systems-focused engineering, to address customer needs.

While customer may carry different meanings, customers typically decide between and use products, services, and action plans that are offered. Determining the customers of education was a heated topic of debate for universities in 1993. Today, however, most university administrations consider their customers, at least in some respects, to be university students, their future employers, educators as well as other stakeholders and benefactors[1]. The purpose of this research is to better understand the future roles that undergraduates may play in workplaces after graduation when they inform, influence, and supporting workplace decision-making audiences. In addition, this research is intended to reveal how educators can influence, and support undergraduates as they prepare for the future.

In this chapter, I explore research studies and theories to better understand workplace rhetorical practices, pedagogical practices currently used by university educators, as well as the range of undergraduate pre-university experiences, which pose obstacles and offer benefits for problem solving. I begin by introducing the relationship of rhetoric with decision making by exploring the theories of Aristotle through the subsequent interpretation and rhetorical theory of Kennedy (1991), Bizzell & Herzberg (2001), Bitzer (1968), Enos & Lauer (1992), Kinneavy (1986), and Berkenkotter & Huckin (1995). To explore rhetoric within workplace problem-solving contexts, I review published works of Bazerman (2002), Selber (2004), Rude (1995), Winsor (1996 & 1998), C. Miller (1994), C. Miller & Selzer (1985), and Carroll (2008).

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[1] By customers I do not mean consumers, which are passive recipients of goods and services. TQM principles drive companies and institutions to understand, meet and exceed the needs of customers and to measure customer satisfaction. The customer and customer satisfaction metaphor is not ideally suited for the active and highly participatory relationships that take place within workplace and education systems. Within these systems, needs are continuously discovered and reconciled, and cannot always be concretely, tangibly or empirically measured.

I then suggest experiences, strengths, and deficiencies that undergraduates might bring to learning experiences they encounter at the university, drawing from Baudrillard (1983 & 1997) and Johnson-Eilola (2005). I then consider university structures and practices and review transformative pedagogies by Freire (1993), Lave & Wenger (1996), Selber (2004), and Gee (2007b) that pose possibilities for guiding undergraduates to practice rhetoric, reflection, critique and networked learning. Finally, I identify gaps in understanding that must be addressed before I can achieve my thesis objective, which is to identify strategies to prepare undergraduate for workplace problem solving.

Rhetoric of Decision Making

The goal of this thesis is to study how workplace problem solving and decision making takes place so that educators can help undergraduates prepare for these challenges. While the mission and objectives of workplace organizations will vary widely, typically workplace organizations engage in activities to produce objects, ideas, and/or services of value to other people, which are often considered as customers. Depending on the context, these customers may be internal customers within the organization or external customers, such as public consumers, other companies and government bodies. People from across organizations coordinate their efforts to plan and implement the development of objects, ideas, and services for customers, and this coordination requires decision making towards action.

I believe that classic Greek philosophy provides an appropriate opening for understanding how people influence decision making. While classic philosophers focused on oratorical persuasion in civic and legal contexts, these pursuits are similar to contemporary workplace practice in their intent to affect change among a public audience. Classical philosophers considered rhetoric to be critical for persuasive oratorical discourse. Prior to Aristotle, Plato had associated the term rhetoric with successful oratory as the "art of persuasion,"

and later Socrates suggested how rhetoric allows orators to "convert listeners to a particular opinion, usually one that will influence direct and immediate action" (Bogost, 2007, p.15). Rhetoric becomes a means of not only persuading an audience but also in urging participatory action or support.

Unlike earlier philosophers, such as Plato and Socrates who explored rhetoric as a means of serving the interests of the orator, Aristotle's theories suggest how rhetoric serves both orator and the typically public audience. According to Aristotle, a speech situation involves a speaker, a subject, and an audience, who will either judge or be a spectator or recipient (Aristotle trans. by Kennedy, 1991, p. 15). Aristotle's definition of situation positioned the audience in an active role within the persuasive exchange. According to rhetorical historians, Patricia Bizzell and Bruce Herzberg (2001), in their book, *The Rhetorical Tradition*, Aristotle understood rhetoric as providing a service to facilitate decision making towards action (p. 145). Aristotelian theory suggests the honorable, ethical, and virtuous nature of rhetorical practice.

While classic philosophers focused on oratorical persuasion in civic and legal contexts, these pursuits are similar to contemporary workplace practice in their intent to affect change among a public audience. Notable examples of classic philosophy are Aristotle's theories on intellectual activity that were presented in several of his works, including *Metaphysics*, as well as rhetorical theory, which he explores in this book *On Rhetoric (*Aristotle trans. by Kennedy, 1991, p. 12). I consider Aristotelian philosophy, in particular, to be essential for understanding workplace decision making, revealing rhetoric as a means to seek specialized knowledge from multiple perspectives to facilitate learning, understanding and productive ends.

Roles of Rhetoric and Disciplinary Specialization in Intellectual Activity

Ethically responsible and productive decision making requires the consideration of multiple specialized intellectual perspectives. Aristotle was largely responsible for defining intellectual activity that evolved to define the areas of disciplinary specialization and curricular

learning of modern universities as well as functional structures of today's organizations. Aristotle suggests four types of intellectual activities: theoretical sciences (such as mathematics and physics), practical arts (such as politics), productive arts (such as fine arts and medicine), and methods or tools, which are applicable and adaptable to all types of intellectual activity (Aristotle trans. by Kennedy, 1991, p. 12). Aristotle considered these categories distinctively unique, and universities continue to define curriculum that fall into the intellectual areas of theoretical sciences, practical arts, and productive arts, which are intended to provide important specialized perspectives.

Rhetoric is unique because it crosses the boundaries of intellectual activity that Aristotle recognized, which include theoretical, practical, and productive. As a theoretical science, rhetoric is a rhetorical *technê*, representing flexible, theoretical approaches or principles for understanding and investigating situations where persuasive action is possible; as a practical art, rhetoric is engaged as a rhetorical *praxis* and conducted according to regularized conventions and approaches; and as a productive art, rhetoric is associated with delivery of speeches and texts (Aristotle trans. by Kennedy, 1991, p. 12). Rhetoric is theoretical, practical, and productive, offering a means of reconciling relevant perspectives in any context so that an argument can be formed and persuasively delivered.

Situated Rhetorical Investigation

Rhetors engage in situations that are placed differently in time (past, present, and future), which require different investigative and delivery strategies and call for different types of audience action. Aristotle defines these different actions or acts as epideictic, judicial and deliberative. For an epideictic speech act, audience is a spectator of discourse intended to prove blame (shame) or praise (honor). For a judicial speech act, the audience is a judge of action taking place in the past. For a deliberative speech act, the audience is the judge of action in the future (Aristotle trans. by Kennedy, 1991, pp. 16-17). These three types of speech acts, described by Aristotle,

are prevalent in contemporary problem solving, but deliberative speech acts are particularly common in workplace settings.

To deliver possibilities to inspire action, the rhetor must determine what is important to an audience, what this audience needs to make decisions, and how to craft an argument to influence this audience. The rhetorical argument conveys the rhetor's proposed solution or course of action through the support of both artistic and inartistic proofs (Aristotle trans. by Kennedy, 1991). For inartistic proofs, the rhetorician interprets and uses previously existing evidence that is considered to be factual in order to strengthen the argument. The rhetor also creates or constructs artistic proofs, which reflect the rhetor's own opinions. Artistic and inartistic proofs are included in the rhetorical argument, in part, to appeal to logos (logic), pathos (emotional), and ethos (credibility) of the audience (Aristotle trans. by Kennedy, 1991, p. 14). Appeals to pathos, logos, and ethos are intended to convey the soundness of the argument as a means of inspiring support and action.

To identify artistic proofs as well as the inartistic proofs that facilitate these appeals, Aristotle suggests that inquiry and investigation be framed around both (logical) common topics and special (contextual) topics. Aristotle identified common topics of inquiry that are considered as purely logic today, such as comparisons of similarity, difference, or degree; definitions of things; whole or parts of things; and cause and effect. In contrast, special topics (or *topoi*) are lines of reasoning typical for specific situational contexts. Aristotle defined special topics for special oratorical situations: the topics of justice or injustice for judicial situations, topics of virtue or vice for epideictic or ceremonial situations and topics of good, unworthy, advantageous and disadvantageous for deliberative situations (Aristotle trans. by Kennedy, 1991, p. 16). Special topics in deliberative contexts, common in decision making that takes place in workplace practice, offers insight into how workplace problems can be investigated to account for broad range of topical perspectives.

Heuristics support rhetorical practice by helping the rhetor determine which common and special topics to investigate. Aristotle suggests that using a heuristic provides a means of uncovering accepted and established norms, enabling the rhetor to build upon the assumptions and understanding that the audience already holds (Bizzell and Herzberg, 2001, 145). The rhetor uses the heuristic to understand the audience's perspective and to determine investigative topics that will enable the rhetor to address audience needs and interests. While the rhetor may be able to recycle heuristics used previously for similar problems, more often the rhetor must generate heuristics by applying heuristic questions (which might include previously established specific research questions and common questioning practices) to identify topics for a particular situation.

To address these heuristic topics, the rhetor plans, investigates, defines and delivers proofs that persuade and inspire action. An investigation that accounts for the audience is likely to inspire *dunamis*, or can-do-ness, in the audience (Crowley, 2006, 55). Aristotle's rhetorical theory as well as the work of contemporary rhetorical theorists are relevant in the situated contexts of contemporary problem solving and decision making where work is intended to encourage decision-making audiences towards *dunamis*, or the confident will to engage in productive action.

Rhetoric in Workplace Practice

Contemporary workplaces are distinct from the oratorical situations studied by classical rhetoricians due to the wide range of multi-disciplinary perspectives that intersect to support productive action. In workplaces the mutual cooperation of individuals with different functional expertise and access to resources is required at different times throughout the process to make products (Bazerman, 2002, p. 348). To accommodate this complex functional web, many workplaces employ TQM practices to frame efficient business processes and encourage rhetorical *praxis* as a means to address the needs of internal decision-making audiences and external customers, including consumers and other societal stakeholders.

These companies engage in rhetoric when they strive to understand their customer's wants (or problems), assign projects to employees to investigate and implement plans to satisfy wants, and craft responsible rhetorical discourse to persuade customers to purchase their products or services. Some workplace rhetorical acts and artifacts are intentionally obvious, such as the marketing messages directed towards inspiring consumption. Yet, rhetorical acts and artifacts also contribute to the productive orchestration of internal workplace activity, even though these acts and artifacts may be naturalized into workplace cultures and may be indiscernibly integrated into practices and processes. Carolyn Rude (1995) suggests that rhetorical practice is an essential part of workplace practice due to "its ability to make sense out of uncertain situations" (p. 32). Those employing rhetorical practice, who I refer to as workplace rhetors, are able to situate their assignments' investigation to be productive, and their delivery of acts and artifacts serves the decision maker because their proposed solutions will reflect the situation.

Tame Problems Versus Rhetorical, Deliberative Problems

Not all workplace assignments are framed or assigned as rhetorical. Selber (2004), whose research interests include computer literacies and the pedagogical dimensions of academic computing, suggests that work assignments will include two types of problems: tame problems and wicked problems that are solved through deliberative activities (p. 154). Tame problems tend to be more simplistic, requiring the problem solver to recall information or follow a process to identify the outcome. "Tame problems are well-defined problems that can be separated from their contexts and other problems" and have "criteria and conditions that signal when acceptable solutions have been reached" (Selber, 2004, p. 154). Tame problems can be more easily solved without consideration of situation, audience or other constraints. In contrast, wicked problems, which I refer to as deliberative problems, must be considered within a situated context. Deliberative problems will not have an absolute or true solution because this implies a single perspective or interpretation of a problem and its system (Selber, 2004, p. 155). Instead,

deliberative problems necessitate flexible investigative and problem-solving approaches to define both important perspectives as well as applicable constraints. Deliberative problems will have "multiple, contradictory solutions, some of which are better than others," making deliberation between possible solutions necessary (Selber, 2004, p. 152). Due to the volume of decisions and the complexity of perspectives needed to orchestrate productive work, workplaces problems are often, but not always, assigned as deliberative. Decision-making audiences often assign projects as deliberative because they depend upon workplace problem solvers to conduct a situated investigation, deliberate over courses of action and propose solutions to inform decision making.

Workplace deliberative assignments have all the elements of rhetorical problems, in part, because they are situated with rhetor, audience, and problem. Deliberative problems, which align with Aristotle's exploration of deliberative oratorical acts, are practical and require an audience to judge options to influence future action. For Rude (1995), practical problems might be "problems of feasibility, problems of choice among alternatives, and problems of cause and effect" and are "too complex for hunches" (Rude, p. 181). These deliberative, rhetorical problems empower the workplace problem solvers to become workplace rhetors.

Rhetorical Situation

For rhetorical problems, understanding audience, criteria, and constraints is important so that the solution and persuasive discourse will meet the needs of that audience. Lloyd Bitzer (1968) extends Aristotle's description of speech situation to emphasize the emotional nature of action taking place within a rhetorical situation. In "The Rhetorical Situation," Bitzer (1968) suggests that the rhetor should understand a problem in the context of rhetorical situation, which has three parts: exigency, audience, and constraints. Exigency (urgency) refers to the importance of the problem and problem goals in a particular time and place. Audience would be those who can be persuaded through discourse (written, verbal, visual, etc.) to act as mediators of change. Constraints are "persons, events, objects and relations that ... have the power to constrain

decision and action needed to modify the exigence" (Bitzer, 1968, p. 8). The rhetorical situation must be understood so that feasible solutions can be pursued.

In workplace contexts, the reach of rhetorical situation is broad and complex. Due to the wide range of perspectives that must be considered for workplace problems, workplace rhetors engage in perpetual efforts to build activity awareness of both their engineering problems and implementation systems. John Carroll (2008) suggests that a problem investigator must continually monitor "developing circumstances and the initiatives, reactions, and sense making of other people with respect to on-going and anticipated courses of action" (p. 1). In addition, workplace rhetors must understand the problem from a historical perspective. With access to the history, rhetors understand the potential of working, creating, and solving problems using systems and technologies (Blackmon, 2007, p. 6). Historical perspective would include the common views and knowledge of the audience, the political environment and the history of any related-problems and the implementation environment.

To problem-solve and communicate persuasively, activity awareness is essential. According to John Carroll (2008), activity awareness requires "monitoring and integrating many different kinds of information at different levels of analysis, such as events, tasks, goals, social interactions and their meanings, group values and norms, and more" (p. 1). For this reason, activity awareness requires workplace rhetors to interact collaboratively with others in the workplace and often outside the workplace to better understand the rhetorical situation surrounding current workplace assignments and to anticipate future action that will impact their assignments.

The workplace rhetor seeks activity awareness primarily to understand rhetorical situation. Activity awareness helps the workplace rhetor realize the needs of audience and the constraints related to ongoing activity and anticipated future activity surrounding the problem assignment. In addition, activity awareness helps workplace rhetors decipher why their

assignments, which were previously defined and assigned by others, are considered as exigent (urgent) for meeting the needs and expectations of their decision-making audience.

Kairos for Engaging in Rhetorical *Praxis* and Employing Rhetorical Technê

Activity awareness provides another important function, by allowing the rhetor to understand, discover or construct *kairos*. Drawing from classical rhetoric, *kairos* refers to the "right or opportune time to do something" (Kinneavy, 1986, p. 80). Kairos will be opportune moments in time that offer greater potential for influencing the decisions, attitudes, and actions of audiences, such as workplace-decision makers. *Kairos* are an opening in a situation in a particular time and place that becomes a "rhetorical void, a gap, a 'problem-space,' that a rhetoric can occupy for advantage" (C. Miller, 1994, pp. 83-4). *Kairos* will encompass all timely opportunities, including previously defined problems as well as emergent and unpredictable possibilities and opportunities. To locate new openings or opportunities the "speaker or writer takes into account the contingencies of a given place and time, and considers the opportunities within this specific context for words to be effective and appropriate to that moment" (Burton, n.d.). Waiting until *kairos* are revealed may seem constraining to rhetors, but once identified, rhetors can form and deliver rhetorical arguments that are more influential, productive, and actionable.

To locate *kairos*, workplace rhetors engage in rhetorical *praxis*, which is application of rhetorical *technê* in different problem contexts to address deliberative, rhetorical problems. To employ rhetorical *technê*, the rhetor in a particular time and place, draws from strategies learned through rhetoric study and experience, which brings awareness for the potential for invention in new situations to form alternative destinations (Crowley, 2006, p. 55). As a *technê*, rhetoric is historical knowledge that invites situated examination in order to generate new, productive knowledge. As a *technê*, rhetoric "can be used as a generative power to create probable knowledge" as well as produce and shape meaning (Enos and Lauer, 1992, p. 81). Problem

solvers apply rhetorical *technê* to engage in a situated investigation as a means to reveal and contribute new knowledge, ideas, and solutions to the productive efforts of their workplace.

Rhetorical Investigation Using Heuristics

Rhetorical investigation is a critical part of rhetorical *praxis* and *technê* because it enables workplace rhetors' to investigate, deliberate, and propose solutions that will address the rhetorical situation. Rhetorical investigation is conducted, not to distort facts, but instead to discover relevant factors that will facilitate persuasion (Rude, 1995, p. 189-196). The importance of discovering relevant factors requires that the perspectives of many stakeholders be considered, including those representing problem-specific, disciplinary, societal, and workplace interests, all of which are important to workplace decision-making audiences. Considering such perspectives introduces an ethical element into workplace rhetorical practice because the interests of others are acknowledged both in the solutions as well as the means of persuasion.

Aristotle's interpretation of special topics, in the context of public oratory acts, does not sufficiently guide investigation in today's complex workplace contexts. For C. Miller and Selzer (1985), special topics in today's context are those patterns of thought that fall into three categories: genre-specific special topics, institution specific special topics, and disciplinary special topics (p. 310). Genre-specific special topics represent the established conventions of specific genres, such as proposals, recommendations, and environmental impact, for example. Institution specific special topics could include concepts that are reflected in an institution's vocabulary. Disciplinary special topics could include shared concepts within disciplinary communities.

Workplace rhetors are expected to use a heuristic as a *technê* to support rhetorical inquiry and investigation. A heuristic is "a method of generating probable knowledge for oneself and others" as well as a *technê* "enabling the rhetor and audience to co-create meaning (Enos & Lauer, 1992, p. 80). Heuristics represent historically successful approaches used to investigate problems. An invention heuristic represents as well as inspires a range of possible, measurable

and contextual special topics to conduct a "systematic and comprehensive investigation" (Rude, 1995, pp. 174 & 196). Using a heuristic reveals the objectives of the investigation so that the needs of decision-making audiences can be met.

Workplaces may convey their preferred heuristic explicitly or implicitly. Some workplaces formally establish a heuristic with the assistance of a committee. Other workplaces expect rhetors to learn workplaces' heuristic expectations through observation or collaborative review and mentoring. By engaging in rhetorical *praxis*, workplace rhetors develop the ability to "deliberate over patterns, structures and frameworks in strategic ways, treating schematized practices as heuristics, not formulas, which are open to analysis and change" (Selber, 2004, p. 155). The workplace rhetor draws from a variety of sources, including the company's heuristic (consisting of special topics used successfully for deliberative problems), activity awareness that surrounds a problem assignment, past problem-solving and collaborative experiences as well as their own heuristic analysis in the workplace. Workplace rhetors use these schemes (or invention heuristics) to guide their investigation in order to find and present a course of action to decision-making audiences through rhetorical acts and artifacts.

Rhetorical Artifacts for Informing Engineering Decision Making

As a means to illustrate how rhetorical problem-solving practices are used to facilitate workplace decision making, I focus on the problem-solving practices of engineers. To produce engineering objects, ideas and services for the marketplace, engineering workplaces depend on decision-making audiences (such as engineering managers) to coordinate productive decision making and implementation. Within most engineering workplaces, individual engineers or engineering groups receive assignments that have been loosely defined first by upper

management and then by supervising engineers. Engineers "do" engineering within the hierarchical structure of the engineering organization.

Rhetorical Nature of Engineering Discourse

Like rhetors working in other disciplines and workplace contexts, the engineering rhetor uses writing and data to demonstrate implicitly or explicitly how conclusions are reached. Dorothy Winsor (1998), who has conducted extensive ethnographic and qualitative research on the writing of engineers, argues the rhetorical aspects of engineering writing, suggesting that the engineer must persuade an audience (management or another engineer or technician, for example) to implement their ideas (pp. 344-5). Audience expectations are addressed most effectively when specified and previously established report genres and subgenres are used. Genre does not refer to the report's form or structure or its textual features but instead refers to the "strategies for structuring intellectual activity (Miller, 1984, p. 154). For example, proposals and investigative reports are common genres in the engineering workplace. Whereas proposals compete with other proposals to offer a convincing solution plan for future work, investigative reports are more prevalent because they are used to inform, influence, and persuade decision-making audiences towards *dunamis*, or action, in specific ways.

Form and Report Registers

Workplaces use registers, often in the form of templates, that they establish over time to guide problem solving, decision making and communication. Registers provide problem solvers with rhetorical framework or model where they can organize quantitative facts and materials and articulate qualitative findings (Berkenkotter & Huckin, 1995). Standard registers for forms and reports may seem like coercive practices, but these registers provide a means for engineering rhetors to construct discourse that will inspire management support and action. The forms and reports change in function through the course of the project. When beginning the assignment, these forms are actively used for recording and collaborating across organizations. These

frameworks enable the coordination of “symbolic social and material transactions” between people with different types of expertise and functional roles and give "presence, meaning, and value” to the engineered object (Bazerman, 2002, pp. 268 & 334). As they are being developed, reports and forms are active, temporarily unstable, and meaningful discourse that are absorbed into discourse stream(s) as speech acts. These forms and reports gain fixity and stability when “accepted as a social fact by others who respect the integrity of the speech act” (Bazerman, 2002, pp. 336 & 345). Acceptance by decision-making audiences brings closure to the project or phase of the project. The accepted form or report becomes a "discursive resting point," which offers "a starting point for new actions" (Bazerman, 2002, pp. 345 & 347). These forms and reports become a part of the workplace's historical record of engineering work.

Workplace cultures vary in their approach and expectations for collaboration and decision making. Engineering rhetors need to understand their institution's preferred approach to decision making that includes the institutional and genre specific procedures for inquiry and communication (Rude, 1995, p. 171). If the engineer uses an alternate approach appropriate for a different genre, the report will not provide the information needed to persuade decision-making audiences, who are often management, to approve the engineer's plans.

Engineering Argument

Most engineers acknowledge that data and graphics play an important role in engineering discourse and communication. Workplace discourse, especially in engineering, is often comprised of information fragments that “provide contextualization clues that invite the audience to make necessary associations, to recognize the interdependence of texts and to participate in the overall meaning-making process” (Mao, 2005, p. 453). Engineering rhetorics strategically present decision-making audiences, who are often engineering management, with information they need to make decisions. While form and report templates are often standardized in workplaces, the rhetorical use of forms is not a "closed and fixed *technê* " and cannot be fully

standardized (Bazerman, 1999, p. 339). For example, the engineering rhetor must present the investigative approach in a way that gives credence to the investigative findings as well to the rhetor's suggestions. Also, data, information and graphics must be presented implicitly and strategically through the form's organization or through additional accepted rhetorical acts and artifacts, such as engineers' interpretation shared during face-to-face discussions with decision-making audiences.

Engineering rhetors must focus on presenting artistic proofs and inartistic proofs in order to support their argument, or recommendation to decision-making audiences. Most engineers rely on inartistic proofs (often in the form of data, fact fragments and graphics) in their discourse and communication to suggest how conclusions are reached during investigation. Artistic proofs serve as explicit links to help the audience understand how inartistic proofs support the rhetorical argument, or recommended action. Artistic proofs enable engineering rhetors to strengthen their argument and make "the products that they produce more legitimate" (Winsor, 1996, p. 1). The values of honesty and integrity are conveyed through the intersection of the artistic proofs -- logos, pathos, and ethos. For example, engineers appeal to credibility and moral character (ethos) when they emphasize the soundness of the engineer's argument (logos) in forms that managers seek. With trust built through their previous work, engineers present their personal perspective (pathos) with the intent of persuasion. The juxtaposition of report elements work together to convey the engineer's logos, pathos, and ethos because the decision-making audience expects this report to provide all information necessary to make a fair decision, even if this information does not support the engineer's proposed course of action.

The engineer uses writing and data to demonstrate implicitly or explicitly how conclusions are reached as a way to inform and influence decision-making audiences. "On the basis of the information gathered and (evaluated), the investigative report answers the question of whether something can or should be done or which course of action is the best" (Rude, 1995, p. 191).

Ideally, the engineer's rhetorical argument will be successful in persuading the decision-making audience, but this argument will never address ALL the pertinent topics important to a decision-making audience. The decision-making audience will try to anticipate additional constraints on the solution outcome (Rude, 1995, p. 198). Ultimately, however, whether the writer's recommendation is accepted or not is irrelevant because the goal of the report genre for decision making is to enable the best decision to be made. The variability of successful rhetorical outcomes reinforces Aristotle's belief that rhetoric is an honorable pursuit intended to serve an audience. For deliberative problem solving, the rhetor's objective is to deliver recommendations supported by artistic and inartistic proofs that reflect a productive investigation in order to inform the audience's decision making.

Learning through Rhetorical *Praxis*

The research of rhetoric and technical communication scholars often reveals that new college graduates overlook the different types of rhetoric they use to build credibility and to solve workplace problems. In the book *Writing Like an Engineer: A Rhetorical Education*, Winsor (1996), points out that engineers, especially novice engineers, often consider engineering writing and data as arhetorical "fact production" (p. 2). Consequently, these engineers fail to realize the kairotic and empowering potential of their assignments. The uninformed perspectives of new engineers may reflect cultural beliefs about technology, which treat engineering documents as "object-bound and data-determined" (Winsor, 1996, p. 2). Such attitudes can interfere with the engineer's successful enculturation into workplace practice.

While engineers and management often engage in rhetorical *praxis*, they might not employ rhetorical terminology as a meta-discourse when discussing these practices. Yet, new engineers increase their level of social cognition (to reflect the social environment or discourse community), which allows them to communicate rhetorically (persuasively) and successfully

(Winsor, 1996, p. 8). Mentoring can provide new engineers with a means for gaining activity awareness and building expertise in rhetorical problem solving.

Many engineering companies consider new engineers' use of form and report templates as appropriate, or “kairotic,” moments for mentoring the engineer in rhetorical practice and employment of rhetorical *technê*. As a part of mentoring, engineering experts guide novice engineers in the problem-solving practices and the appropriate language (disciplinary and otherwise) for that particular workplace culture (Winsor 1996, pp.106-7). Mentoring new engineers in report template use, such as the A3 project planning reports studied Chapter 4 of this thesis, can be useful for understanding workplace practices, such as the workplace's heuristic for investigation. Experienced employees guide new employees in practicing the workplace's regularized way of doing work and gathering information that makes working between people across organizations possible (Bazerman, 1999, p. 268). These new engineers enjoy an apprentice-type relationship with senior engineers. Workplace relationships are forged to help people make meaning and (potentially) reach consensus in respect to coded information, including text, data, and oral, to support rhetorical problem solving (Johnson- Eilola, 2005, p. 125). Often experienced engineers direct new engineers to seek guidance from other experts or find solutions independently, and this practice is considered to be beneficial when engaging in future work assignments.

Perspectives of New Undergraduates: Technology, Problem Solving and Collaboration

When engineering undergraduates arrive at the university, they will have experiences as decision makers, particularly as decision-making consumers of a wide array of products and technologies. The engineering undergraduates' role as decision-making consumer is very different from the decision-making audiences they will encounter when they address deliberative

problems in workplace systems after graduation. This disjunction is amplified further by the technology forecasting efforts of many of today's industries. While *kairos* in engineering workplace systems are often opportunities to inspire action to address a current or upcoming need, *kairos* in technological market places are often exploitive, representing "opportunities for opportunity" (C. Miller, 1994, p. 93). Such companies pursue a predominantly capitalistic quest for technological change that enables them to create a market for more advanced, more intuitive and more transparent simulation technologies.

The engineering undergraduates' experience engaging with technology will offer advantageous and pose challenges to rhetorical problem solving activities. Today's engineering undergraduates have greater access to information and tools for tinkering and communication than the students who students who precede them. Yet, their expectation for information immediacy, their drive towards self-reliance, and the transparency of the technologies themselves could undermine their initiative to engage in problems as deliberative and rhetorical. Further, due to differing interests and varying access to information and technology, engineering undergraduates will arrive at the university with different knowledge, experience and attitudes about technology use. To leverage undergraduate perspectives and experience to enhance learning, universities (as well as curriculum planners and educators) will need to understand how rapid technological advancements are changing the ways students use technologies, communicate and solve problems.

Simulation Transparency

Today's engineering undergraduates have open access to information on the Internet through a wide selection of search engines as well as access to flexible, intuitive and transparent simulation technologies. Baudrillard (1983) suggests that simulations are reproducible models, consisting of signs that have replaced signs and symbols of the real (p. 108). Undergraduates

often engage extensively in technology simulations that model productive activities that traditionally have required human engagement.

Our undergraduates are invited to engage with inanimate simulations, which will limit opportunities to fully engage in rhetorical *praxis*. Baudrillard contends that when we encounter simulacra, we follow a natural procession of engagement. First, we fall into a trance, not due to the accomplishments of the simulation, but due to the "immanent wonder of the programmed unfolding of events" (Baudrillard, 1997, p. 34). In this stage we engage with technologies passively, such as when we open up Facebook and look at the interface. This wonder evolves into a "fascination with the maximal norm and the mastery of probability" where we accept the simulation as the real without inconsistencies and flaws (Baudrillard, 1997, p. 34). In this second stage, we succumb to natural curiosity by experimenting, playing and tinkering uncritically and indiscriminately with the simulation's capabilities. The third stage is when the technology "escapes representation" and seems transparent (Baudrillard, 1997, p. 108). This is when we use the technology intrinsically as a “pseudo-natural” way of thinking and doing (Clark, 2003, p. 45). Simulations that have reached the point of transparency will not prompt the user to disengage from the technology long enough to critically reflect on its situated use in order to detect inconsistencies and flaws. Further, these simulations often strive to provide rewarding yet independent, limited-scope and arhetorical decision-making opportunities that are not consistent with the rhetorical problem solving, investigation and decision making that take place in the complex work and disciplinary systems where students will engage after graduation.

Access to Information Dataclouds

Several researchers believe that the technology advancements and information access are changing society in dramatic ways. For example, Johndan Johnson-Eilola (2005) suggests that learning, thinking, working, inventing and communicating are changing in the "structurally dense" and "intentionally chaotic" information and communication structures, simulations (tools

and representations) and work processes of today's information society (pp. 31-32). Many people explore the Internet, locating "disparate chunks of symbolic information" and engaging in informal thought. Information becomes something that is not mastered or simplified, but as a place to seek "interesting juxtapositions, and commentaries" (Johnson-Eilola, 2005, p. 17). Many engineering undergraduates share this interest in the Internet and often spend an exorbitant amount of their free time on the Internet, where they play video games, surf YouTube, chat on Facebook and conduct research to inform their consumer purchases.

Tinkering with Technology

This progression of engagement takes on new meaning on today's Internet, when information dataclouds and simulation technologies are employed concurrently. An empowered public engages in activity that is "contingent, experimental, loosely goal-driven, playful" (Johnson-Eilola, 2005, p. 3). They tinker with technologies and manipulate information to invent solutions and create artifacts, often to entertain peers, but only rarely to solve practical problems encountered by a wider societal audience. These self-made inventors circumvent industry gatekeepers by using their contributions in local contexts or uploading them as an “open” source to the dataclouds of the Internet.

Virtual Communication: Virtual Communities and Affinity Groups

More recently, the public has begun to move beyond self-reliant and isolated invention and creation to seek the companionship and support of virtual communities. Virtual social communities, such as Facebook, have become a common place to find encouragement, camaraderie, and social recognition. In addition, the public is empowered to upload creative artifacts through such social communities and social distribution networks, such as YouTube.

These virtual social communities and distribution spaces provide intuitive tools for uploading content and locating like-minded peers, which encourages the creation of special-interest groups. These impromptu discussion groups form in communication networks that span

cultures and geopolitical borders and dissolve as interests change (Hawisher & Selfe, 2010, pp. 72-73). These groups can be casual, such as the fans of specific YouTube contributors, music fan clubs or the participants of Farmville on Facebook. Groups can also be more formal, in the form of affinity groups. Affinity groups share interests and become insiders in a common domain (Gee, 2007b, p. 23; Haraway, 1988, p. 156). Such affinity groups offer discussion, specialized assistance, critique and encouragement for those in pursuit of specific goals. Affinity groups, considered as commonplace for adults, are cropping up for high school students as well in places like Facebook, where, for example, my son participates in a group with fellow physics classmates. In these affinity groups, the high school students can help each other learn physics by sharing perspectives, by sharing links to open source Internet resources such as Khan Academy, and by strategizing approaches to solve tame problems.

Varied Access to Deliberative Problem-Posing Opportunities

Our undergraduates have enjoyed success in solving tame problems in K-12 instruction and on standardized tests. Tame problems, those with clearly defined right and wrong answers, are common in K-12 instruction for several reasons. K-12 institutions (and higher education institutions) have a tradition of helping students to build a foundation of disciplinary-knowledge, which can be easily measuring through tame problems assessments. Like workplaces, US education systems have adopted TQM principles. K-12 schools strive to provide a quality education that meets the needs of customers that include students, governments and higher education institutions. Educators and schools are measured by their students' success on standardized tests, comprised of mostly tame problems, and educators must focus instruction on providing students disciplinary knowledge that will help the student succeed on these tame tests.

Ideally, from their kindergarten through high school (K-12) instruction, our students will have gained experience applying online information resources, engaging in learning communities, and connecting to the Internet to address assigned deliberative (and therefore rhetorical)

problems. In addition, these students may have participated in guided, situated problem-seeking and solving opportunities, such as the FIRST (For Inspiration and Recognition in Science and Technology) family of programs that has inspired my thesis research.

Yet, if students' experience is only solving tame problems in school and if their experience using Internet technologies has been solely tinkering and creating in the absence of specific problems, they will likely take a simplistic approach to solving deliberative problems when they finally do encounter them. They may go through the motions of following a procedure but will not realize the kairotic opportunity for influencing others, advancing understanding or building expertise. These students may disregard important foundational knowledge, situational details or ethical considerations in the context of their creations. Further, these creative artifacts may hold meaning in their novelty, but not in their use because they do not address an urgent (rhetorical) problem.

Undergraduates will not develop the critical thinking experience necessary to understand a simulation's inadequacies and strengths in contrast to other ways of doing. With this limited perspective on problem solving, these students may believe that that computers and technologies will solve open-ended problems for them (Selber, 2004, p. 47). Yet, undergraduates will have much to offer in undergraduate learning environments, such as diverse perspectives and experience tinkering with technologies, using Internet resources to find information, using multiple technologies and information chunks to create, and learning in virtual learning communities. To prepare students for workplace problem solving, universities can provide collaborative learning and problem-solving opportunities that take advantage of these strengths.

Traditional and Emerging Problem Solving Pedagogies for Undergraduate Education

Universities continue to struggle with how to meet the needs of students, especially since students' long-term educational needs are challenging to predict. Universities have implemented techniques, commonly used for external customers in the corporate world, to determine how student wants, or desires, can be met. For example, universities implement course evaluations and student experience surveys to make sure educators are responsive to student needs (Sappey & Bamber, 2005). While educators draw from course evaluations to improve classroom practices, these evaluations may not be particularly useful for understanding student needs. "Students may say they want an easy 'A', when (their long-term want) is an education" (Winn & Green, 1998, p. 25) that is useful for initiating and supporting their career path, whatever directions that path may take. While students may measure education success with grades, high grades that don't reflect learning will not impress prospective employers, who would "quickly learn to avoid hiring the graduates of that university" (Winn & Green, 1998, p. 25). To address students' long-term need for an education that will prepare them for the workplace, universities encourage student internships and cooperative opportunities in industry and invite industry professionals to present and teach. Also, universities establish industrial advisory boards to direct degree program focus and adjust curricula to reflect accreditation board requirements. Educators sometimes seek research opportunities to study workplace practice. For example, an NSF study on Engineering Education, conducted by educators from several universities, has gone so far as to suggest how educators should help students develop the critical thinking skills they will need for workplace problem solving (Woods et al., 2000). The findings from this study are summarized in Table 2.1:

Table 2.1
Pedagogical considerations for teaching critical thinking skills.

- Identify skills that are essential in industry.
- Help students make connections between problem statement, technical knowledge and the problem's solution.
- Solve some problems in depth and allow students opportunities to practice individually or in small groups with opportunities to obtain feedback.
- Encourage students to check the soundness of their approach during and following problem-solving.

Source: Woods 2000

From these considerations and ABET requirements, curriculum planners have built programs by identifying course modules that are situated within different disciplines to teach undergraduates technical and professional skills. As part of curricula, students are required to complete a capstone project or participate in enterprise, where deliberative problems are common. Students are also encouraged to complete internships or coop experiences in workplaces, where they will gain real-world experience in deliberative problem solving. Many courses include deliberative problems (which have no right or wrong answer and require students to propose a solution) as a way to give students opportunities to develop professional skills, which include problem solving, teamwork, and communication. On course evaluations, students generally indicate a dislike for these problems, which seem artificial and, therefore, irrelevant to their long-term goals (preparing for the workplace). In addition, students find achieving short-term goals (to get A's in their courses) more complicated, and, therefore, uncomfortable, when educators assign deliberative problems. From the students' perspective, deliberative problem assignments are time-consuming, require coordinated efforts with those with varied commitment, and are assessed using qualitative measures that seem ambiguous. Students are particularly critical when deliberative problems are posed in courses outside their chosen field of study and, for this reason, seem to have little relevance to their long term goals.

These criticisms suggest the student's lack of awareness of how real-world problems are solved and implemented in workplaces as well as how preparing for these challenges is an exigent concern. Deliberative problem-posing games, where the aim is to prepare students for workplace problem solving, hold much promise in undergraduate education. Such games promote student agency and provide opportunities for rhetorical practice, which includes understanding rhetorical situation, conducting inquiry, and persuading an audience(s) to mediate a solution's implementation.

Tradition of Teaching-Focused Games in Undergraduate Education

All university courses, regardless of the pedagogical approach or delivery, have characteristics that are intrinsic in games and play. Some common characteristics are provided in Table 2.2:

Table 2.2
Game-play features in most university courses.

- Clear or vague rules
- New perspectives
- Different ways to think and communicate
- Goals to develop unique expertise
- Identity and interactivity
- Somewhat uncomfortable, challenging situations to inspire learning and discovery
- Fair assessments and feedback
- Potentially serious play that is different from ordinary life

Source: Compiled by Jean DeClerck from Huizinga (1950), Gee (2007a), Flanagan (2008) and Daisy (1994)

A game frame is useful in learning contexts because it provides educators with a means to verify knowledge sharing and measure mastery. A game frame poses simulated experiences that emphasize goals and achievement, making it more effective for learning than other types of simulations (Gee, 2007a, p. 148). Yet, most educators are not aware that their current

pedagogical practices are situated in a serious game frame, nor do they see the potential of a game frame to help undergraduates learn.

While student learning is an important objective for educators, many university educators still practice a knowledge-telling, transmission model of instruction as a means of depositing knowledge in students. Paulo Freire (1993) criticized a “passive” banking-style of instruction, where educators, as experts, deposit knowledge in the student (p. 77). In teaching-focused instruction, students are expected to develop knowledge through the teacher's scaffolded access to knowledge and understanding. The teaching-focused approach is problematic because educators “supplies -- and thereby limits -- structuring resources for what is learned, which will address only the instructor's perception of what knowing is about" (Lave & Wenger, 1996, p. 97). In addition, some educators rely primarily on passive modes of instruction, such as lectures, to deliver their perspective. Technologies, employed for teaching-focused instruction, might be used to enhance the educator's delivery or deliver tame questions to help educators verify the student's understanding of the educator's perspective. While this is an important part of helping students learn, this teaching-focused means of instruction does not empower students to seek or confirm understanding.

Many educators, particularly those in the Humanities, have begun to adopt a learning-focused approach in their classrooms. In learning-oriented instruction, educators remain as the locus of authority, but act as guides or facilitators. These educators remain essential to learning by providing resources, mentoring guidance and comfortable spaces for students to share their perspectives and explore the application of knowledge in hypothetical situations (Lave & Wenger, 1996, pp. 93-94 & 97). A learning-focused approach includes more resources and opportunities for situated and collaborative learning, which are important elements of a realistic participatory experience. While educators outside the Humanities also employ learner-focused pedagogical approaches, they may not explicitly acknowledge or guide students in the use of rhetorical

practice, cultural awareness and technology politics that are required for real-world problem solving.

Situated Deliberative Games for Learning-Focused Instruction

Ideally, undergraduates will contextualize what they learn in their classes within their own experiences; yet, problem-solving experiences will vary widely between students. To provide all students with the opportunity to contextualize their learning, educators can design situated games. Academia tends to discard ideas of games in classrooms, drawing from “traditional conceptions of work and play that highlight differences between classroom space and game space as binary opposites” (Colby & Colby, 2008, p. 302). Play is often considered to be a stepping out of “real” life into a temporary magical circle of activity and can seem frivolous. Yet, situated games and play can be very serious. Serious game experiences can provide learning communities of practice, where students build understanding and contextualize this understanding through the enculturation into practices (Lave & Wenger, 1996, p. 92). These games create order through strict rules, contextual information and/or fixed limits of time and place.

Many theorists have considered the potential of serious game experiences in instruction. Designers can use a serious game framework "to model the complexity of the problems that face the world and make them easier for the players to comprehend” (Flanagan, 2009, p. 249). The concept of situated games in education is reminiscent of Paulo Freire’s (1993) problem-posing education. While Freire’s intentions were to support revolution and empowerment among subordinate societal groups, his ideas for innovative change and agency have a practical place across disciplines.

The cycle of learning evident in a situated deliberative problem-posing game (Figure 2.1) is reminiscent of Paulo Freire's (1993) model of a problem-posing education:

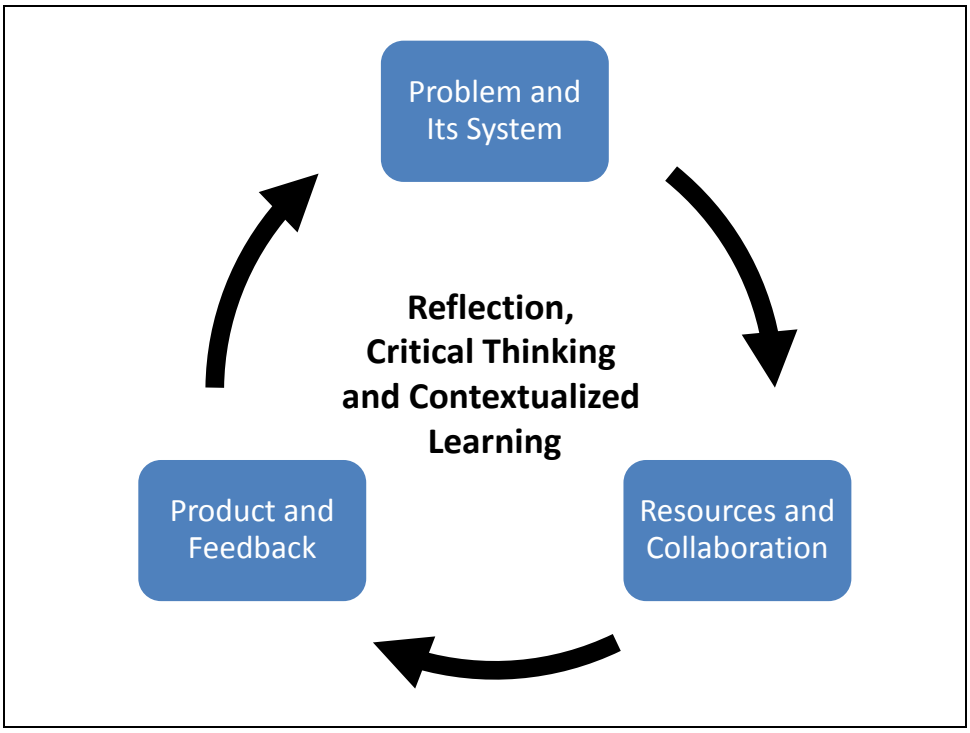

Figure 2.1. The cycle of learning possible for situated, game-play pedagogies.

Note: This figure was inspired by the work of Flanagan (2009), Bizzell (2003) and Freire (1993) and created by Jean DeClerck.

Critical thinking and reflection take place throughout the stages of the cycle of learning. During the problem and system realization stage, students explore and understand rhetorical situation. During the resources and collaboration stage, students conduct inquiry and investigation and reconcile perspectives within the learning community. During the product and feedback stage, students deliver persuasive discourse and receive feedback. Throughout this cycle, students reflect critically upon their activities and contextualize learning outside the game system.

First Stage: Rhetorical Situation

Understanding rhetorical situation, which consists of problem, audience and constraints, is critical to problem-solving success. During a situated, deliberative problem-posing game, educators guide students in understanding both the fundamental problem as well as the systems that surround the situated problem and implementation environment. Unlike tame problem, deliberative problems posed in game-style experiences will not have a solution that can be proven definitively. Instead a preferred solution, or course of action, can be found to satisfy the needs of the audience. Understanding a problem within a game begins with determining what the problem is and what the customer, or consumer of the product or service, really wants.

The critical study of existing systems and ways of addressing problems is considered to be a key requirement for creative problem solving and innovation. Gee (2007a) suggests that the student must be able to "think about the domain at a meta level as a complex system of interrelated parts" (Gee, p. 23). Understanding the domain system where the final solution, or course of action, will be implemented is important. The game is typically, but not always, a simulation that mimics an existing system within the chosen domain. To allow the students' customizing strategies to be beneficial for problem solving in the real world, educators should help students understand a problem-solving model that is appropriate for the game domain. Educators would either explain or help students research a problem-solving model that would include interrelationships between different functional roles.

The role of the student within the game system is very important, and ideally the student will be a problem solver. Determining the game system and the student’s role in the system, according to James Berlin, is the “version of reality and the student’s place and mode of operation in it” (as cited in Haynes, 1998, p. 81). Through meaningful, role-playing, the student develops an understanding of rhetorical situation that will drive investigation.

Second Stage: Inquiry and Investigation

Regardless of the career path our undergraduates choose after graduation, undergraduates will be expected to draw from a variety of resources to build the workplace and disciplinary expertise necessary to investigate deliberative workplace problems. To prepare students for these investigative endeavors, universities have always offered a blended learning experience, where students learn from a variety of experts in courses. In the past, expertise in teacher-focused instruction has been limited to course instructor, the textbook's author(s) and (perhaps) the emerging shared expertise of students. Yet, in today's classrooms, the blended use of expert resources has taken on new meaning due to the vast array of resources that are available and to the emergence of powerful simulation technologies.

The blended use of expert resources, simulations and data offers different perspectives and information for students to consider in their learning. In learning-focused instruction, educators build learning communities, where students sort through perspectives together with educators. Such communities invite students to share their own ideas and to reflect on the perspectives held by experts as a way to build (not replace) understanding and contextualize what they explore in their undergraduate classes. Expert (including educator) perspectives as well as student perspectives can be collaboratively arranged and interrelated to form new understandings (Lave & Wenger, 1996, p. 96). New understandings enrich and strengthen ideas, making innovation in both knowledge making and problem solving possible.

Due to clear definition of roles and identities, situated deliberative problem-posing games provide ideal opportunities for learning communities. Through their research in different apprenticeship contexts, Lave & Wenger (1996) found that learners consider the legitimate sponsorship into a community of practice “more important than the teaching of the master" for learning a specialized occupation (p. 92). Apprenticeship, then, becomes more than just a

master-apprenticeship relationship and instead emphasizes a supportive community of apprenticed peers and experts with productive aims.

Within this new context of the participatory learning community of practice, scaffolding takes on new meaning. "Apprenticeship learning is not work driven," but instead "production activity-segments must be learned in different sequences than those in which production process commonly unfolds, if peripheral, less intense, less complex, less vital tasks are learned before more central aspects of practice" (Lave & Wenger, 1996, p. 96). This logical scaffolding structure is also used effectively in undergraduate education to help students learn. Like apprenticeships, undergraduate courses are not organized for sequential learning to support a problem-solving process. Instead, courses are ordered so that less complicated and essential skills and knowledge are addressed first. Yet, to optimize the potential of situated game experiences with deliberative problem challenges, students must be able to situate course concepts within their curricular system and workplace problem-solving systems. To contextualize course concepts within a curricular system, educators can provide examples (or case studies) to provide context, "offering general theories or patterns, relating concepts to previous knowledge, describing concrete or abstract models, and indicating examples of incorrect use" (Selber, 2004, p. 70). For example, in a classroom context, a mathematics instructor teaching differential equations might contextualize learning in case study examples to demonstrate how this math would be used in a variety of disciplines and future courses student may take as undergraduates.

To contextualize concepts within workplace problem-solving systems, educators can help undergraduates develop a rhetorical *technê*. *Technê* is "less a mode of revealing or discovery" than it is a process for extending accepted knowledge through "productive technical intervention" to generate new meanings and to "persuade themselves and others that the artifacts they have created offer a legitimate contribution to existing knowledge" (Wickman, 2012, p. 38). A *technê* for rhetorical problem solving would facilitate the blending of accepted knowledge, often the focus

of undergraduate instruction, with the situated aspects of deliberative problems with the purpose of advancing knowledge, evolving designs, or both. Rhetorical *technê* through *praxis* would empower students to actively engage knowledge making. As a part of *technê,* heuristics would help students draw from their knowledge and experience with technologies to solve problems. A heuristic provides a systematic way to plan a situated investigation.

To understand the use of heuristics and the perspectives of experts, learning communities of practice become essential, allowing undergraduates to engage, reflect, analyze, critique, and situate within the context of a problem solving. The students continue to explore several possible solutions and consolidate until they have "rhetorically sophisticated" plans to address the deliberative problem at hand (Bartholomae, 2003, p. 629). These plans can then be communicated persuasively to a decision-making audience.

Third Stage: Persuasive Discourse

Discursive artifacts, which are typically formal documents like reports, are used by problem solvers to persuade decision-making audience(s) to accept their plans, ideas, course of action, etc. Activities for making and exchanging discursive artifacts are just as important in situated, deliberative problem-posing games as in workplace problem-solving contexts (Aldrich, 2009, pp. 68-69). Educators can make the game scenario more real by assigning artifacts that are similar in form or function to those used in real workplace problem solving. This is particularly important when interaction between students takes place in virtual spaces, because educators can easily provide feedback to students when thoughts and plans are captured and exchanged digitally in documents.

Educators guide students in capturing their ideas using customizable worksheets and formats, a practice that advances thinking and facilitates efficient sharing and collaboration. Such forms and formats provide a starting point for students to practice rhetorical delivery in the context of a social environment or discourse community. In addition, peer review or analysis of work

(such as reports) provides opportunities that invite the learner to adopt a “productive reflective stance” (Gee, 2007a, p. 137). The user’s personal values and experience existing both in the real word and in the virtual spaces of the game bring a unique perspective to the act of reflection, allowing the user to critique how the artifact (or report) facilitates or interferes with the completion of actions, goals and strategies that make success possible.

Challenges of Implementing Serious Games in Instruction

While I believe that serious game-style experiences that simulate scenarios of workplace deliberative problems could help undergraduates prepare for workplace practice, such game experiences are not always practical to implement. As undergraduates proceed along a curricular path, they encounter a variety of discipline-specific course modules. This curriculum structure both offers efficiencies and imposes obstacles for preparing undergraduates for the deliberative problem-solving experiences they will encounter in the workplace.

In discipline-focused courses, undergraduates benefit from expertise that is centralized in university disciplinary departments and schools. Discipline-specific course modules will typically provide problem opportunities that emphasize the scaffolded learning of discipline-focused knowledge and process that is essential preparation for workplace practice. Yet, problems posed in these courses are typically arhetorical and promote "routine production rather than symbolic-analytic work" required in today's workplace problems, which require the integration of many cross-disciplinary perspectives and data sources to solve problems (Johnson-Eilola, 2005, p. 99). When undergraduates do encounter deliberative problems in their courses, they often approach them as tame problems, falling back on their tendencies to accept the first "cool" design they encounter instead of pursuing multiple solutions to find the most appropriate course of action to suit the rhetorical situation at hand.

These undergraduate attitudes make preparation for workplace practices a deliberative problem for universities, curriculum planners and educators. Educators, whose goals and experience often reflect a dedication to advancing knowledge within disciplinary cultures, often do not have experience solving problems within cross-disciplinary workplace cultures and may not be able to guide students in these practices. Due to their disciplinary focus, educators will often avoid implementing pedagogies that emphasize cross-disciplinary problem challenges, such as those found in the workplace. For example in engineering curricula at my university, cross-disciplinary problem challenges are presented to undergraduates in a first year engineering fundamentals course and then again in junior-level and senior-level capstone project courses. With such limited opportunities to engage in cross-disciplinary problem solving, undergraduates will likely be oblivious to curricular structure and goals. Such students may envision courses (as well as assignments and the instruments for assessing mastery that courses contain) as the work of school, as autonomous activities, and as unrelated to real problem solving (Haas, 2001, pp. 360 & 370). Understanding workplace practice and guiding undergraduates in preparing for these practices becomes an exigent deliberative problem for educators and curriculum planners.

Conclusion

As this literature review demonstrates, research conducted in workplaces has revealed the rhetorical and deliberative nature of workplace problems. My review of literature also suggests that our undergraduates will bring different perspectives, attitudes and experience to their undergraduate studies in respect to problem solving, technology use and collaborative learning. Finally, I have explored the potential of situated deliberative problem-posing games as a way to prepare undergraduates for workplace problem solving. These game experiences provide learning opportunities that help undergraduates contextualize their learning within curricular knowledge-building systems and workplace problem-solving systems. These problem-posing

experiences also stress the importance of rhetorical principles, cultural practices, and technology critique in problem solving.

Preparing undergraduates for deliberative problem solving is becoming an exigent concern because undergraduates' futures, university reputations and even possibly educator morale are at stake. Preparing undergraduates for deliberative problem solving has all the elements of a rhetorical problem, beginning with educators' understanding of rhetorical situation. Like other deliberative problems, educators may address this problem in a myriad of ways and degrees through learning opportunities that work rhetorically to inspire participation in these learning opportunities and to contextualize learning. Yet, in the end, the students, as decision makers in their education experience, will consider the learning opportunities available to them and will either choose or decline to participate in an educator's course of action.

Due to the fact that workplace problem-solving preparation for undergraduates is an exigent, deliberative problem, I will use the deliberative problem-posing model, which I have explored as a pedagogical approach in this chapter, as a frame to conduct my thesis investigation and pose a course of action to universities. In Chapter 3, I will describe the methods and methodology I employed to extend my understanding of the workplace problem solving (the rhetorical situation). In Chapter 4, I present a heuristic analysis of two engineering reports, which informs my understanding of the rhetorical situation surrounding both workplace problem solving and undergraduate learning. This understanding inspires further analysis of engineering managers' interviews as well as my suggested course of action, which I deliver in Chapter 5.

Chapter 3

Methodology

Forecast

My purpose in this thesis is to suggest ways in which universities, curriculum planners, and educators might help undergraduates, who are often accustomed to arhetorical problem solving and technology engagement, to prepare for future problem-solving challenges. My review of literature reveals how workplace problem solving and writing is often situated rhetorically within cross-disciplinary systems and how deliberative problem-posing game systems and other learner-focused approaches are encouraging possibilities for preparing undergraduates for rhetorical problem solving. Yet, published workplace research did not reveal how rhetorical problem solving and decision making takes place in the workplace.

In order to pose pedagogical approaches that help prepare and empower undergraduates to participate fully in rhetorical problem solving and workplace decision making after graduation, I investigate three topics: workplace rhetorical practice, common challenges, and workplace learning. I use the following questions to frame my investigation: How do engineers use rhetorical practices, culture awareness, and technologies to support their engineering assignments? What rhetorical practices in engineering problem solving are particularly challenging for new engineers? How do engineers learn rhetorical practices in the workplace? How can educators help prepare undergraduates for workplace problem solving? To investigate these questions, I conducted a workplace research study, where I interpretively and contextually analyzed two engineers' decision-making reports and interviewed three engineering managers.

Since workplace systems are complex, situated and evolving, I have employed methodological triangulation, which is the study of multiple and heterogeneous perspectives in search of patterns and counter-patterns to balance bias. I believe that the analyses of multiple perspectives lead to new understandings with future benefits for those who will find themselves in these roles, including undergraduates, educators and employers. In the remainder of this chapter, I will summarize how my interests and perspective led to my interest in my research questions, and I present the methodology used to answer these questions. I explain how my interest and perspectives shape and inform my research. Finally, I include the investigative heuristic used, and I include an overview of participants and methods.

My Interests and Perspective

My interests in this thesis research grew out of my experience inspiring and helping young people prepare for careers science and engineering. This interest has followed me through my own undergraduate education, work opportunities and coaching experience for FIRST LEGO League competitions, where I fostered learning communities and guided learners in deliberative problem solving. I've continued to pursue this research interest throughout my graduate school experience by seeking opportunities to learn how educators are using learner-focused and deliberative (rhetorical) problem-posing pedagogies to help learners build rhetorical problem-solving skills.

I began studying learner-focused and deliberative problem-posing pedagogies in my first semester, in Fall 2009, when I conducted a linguistics study as part of a final project for Dr. Victoria Bergvall's HU5030 Linguistic Analysis course. In my study, I observed how Professor Chuck Van Karsen engaged his a junior-level Mechanical Engineering Vibrations class and encouraged them to learn collaboratively. This study revealed the undergraduates' use of

(informal) affinity groups as well as the educator's use of situated case studies and participatory, learner-focused pedagogies to encourage their learning and engagement.

In Fall 2010, I served as a teaching assistant for Dr. Wendy Anderson's HU2642: Introduction to Digital Media course, which focused on hands-on production as well as discussion and analysis of contemporary issues related to digital media communication. Her course provided a foundation in tools, techniques and processes through hands-on production, readings, discussion and analysis of contemporary issues related to digital media. Throughout the semester, I observed how Anderson fostered a learning community, where students safely shared perspectives and helped each other design with technologies.

Also in Fall 2010, I enrolled in a multi-disciplinary Responsible Conduct of Research (RCR) course for graduate students, taught by Deborah Charlesworth, Assistant to the Dean of the Graduate School. In this course, Charlesworth used technologies in clever ways, including the use of clickers during class to form spontaneous affinity groups as a means to discuss a common perspective to share with the class (an idea-pair-share approach that I've seen used by other engineering faculty as well). Charlesworth also used discussion boards to enhance meaning making through the sharing of students' multi-disciplinary perspectives. During this time, I also met Dr. Ann Brady, who shared my interests in cross-disciplinary research and rhetorical problem solving and who had leveraged technologies creatively to encourage participatory learning in her distance learning Technical Communications courses.

Between Spring 2010 and Spring 2012, I supported two NSF grants to investigate the use of pedagogical approaches to support situated, rhetorical and deliberative problem-posing challenges. This investigation began in Spring Semester 2010 and continued for two years as a part of my work on two National Science Foundation research grants. The first of these grants, the NSF Ethics Education 2.0 in Science and Engineering (EESE) grant, was offered to STEM graduate students so that they could learn about patents and copyright in collaborative group

activities. For the second grant, the NSF Research Experiences for Undergraduates (REU) grant, I supported the delivery of an ethics education series to undergraduates in engineering disciplines. This research allowed me to apply new pedagogical theory to instruction.

While these learning-focused experiences helped me understand how engaged students can benefit from learning communities and opportunities, my informal conversations with students and faculty across campus revealed that, even when courses are delivered with learning-focused approaches, students do not always choose to engage in the learning opportunities that educators offer them. During my study of published research, I came to understand that undergraduates may find it difficult to envision how their courses help them prepare for future careers when students don't understand how knowledge and activity are linked within systems. This understanding, which I refer to as systems thinking, enables undergraduates to draw from knowledge gained through many sources of knowledge (even course modules) and to present viable solutions in response to rhetorical, deliberative problems posed within curricular and future workplace systems.

I began to see the undergraduates' ability to employ contextual, system-focused thinking to solve deliberative problems as an exigent concern because undergraduates' futures, university reputations and educator morale are at risk. To explore the rhetorical situation of this exigent concern, I conducted a workplace study to understand how situated, deliberative problem-solving practices are learned and how they are influenced by rhetoric, culture and technology within systems.

Workplace Research

Prior to beginning the workplace research study, my research in guiding undergraduates in engineering problem solving had been contextualized through my personal experiences and the theory I explored in my graduate school courses (as described in Chapter 1). To better

understand the rhetorical situation of my research, I felt that activity awareness in the engineering workplace was essential.

The following methodology reflects the two phases of my workplace research study, which include the preliminary rhetorical analysis of two engineering reports, used for project planning and decision making, as well as subsequent interviews with engineering managers to deepen my understanding of workplace problem solving, in the context of rhetoric, culture, and technology. I include a description of my research approach, my role as researcher, the research participants and my methods. I have assigned pseudonyms to all the engineering managers, who participated in this research, as well as the names of their companies.

My Research Questions for the Workplace Research Study

When I began this study, my understanding of workplace problem solving stemmed from my own work experience and the theory posed by workplace researchers, such as Dorothy Winsor (1996 & 1998), Carolyn Rude (1995) and Johndan Johnson-Eilola (2005). Winsor (1996 & 1998) illustrates how engineering problem solving is rhetorical. Rude (1995) explains how often-deliberative (and therefore rhetorical) workplace problems are communicated in accepted reporting genres. Johnson-Eilola (2005) suggests how workplace problem solving requires locating and manipulating data to address problems. Yet, my review of literature did not help me understand how workers (and engineers in particular) apply rhetorical principles to not just communicate solutions, but also to solve workplace problems and how they learn and develop expertise in these practices.

I embarked on a quest to determine how rhetorical practice plays a part in engineering problem solving. I contacted an engineering manager, Mervin from the Megalith Company, who confirmed the importance of rhetoric in engineering decision making at Megalith and provided me with two decision-making reports, in the A3 style-format, for me to analyze. Megalith's report template (Appendix E) is a derivative of Toyota's A3 report, which was named A3 because it was

printed on European A3-size (approximately 11” by 17”) paper. Since Toyota introduced the A3 report in the 1960s, the A3 report has become widely recognized as an essential technology for conducting business (Shook 2009). Many industries consider A3 reports, customized for particular needs of an organization, as a standard workplace practice. Organizations use A3 report templates to help employees form and document their approach to inquiry and investigation in a way that is useful for organizational decision making. For this reason, organizations often use A3 reports are also used to mentor new engineers in organizational practices, which was the case at the Megalith Automotive Company.

For this initial phase of the project, I began the heuristic analyses of A3 Reports in the context of the Megalith Automotive Company's practices. Mervin provided a template and two A3 reports for my analysis, which included both a well-constructed, complete report and a poorly constructed incomplete report. The incomplete report included Mervin's typed feedback comments to his engineer. To study these reports, I chose to conduct a heuristic analysis, which is an approach grounded in classic philosophy and used today in many contexts. For example, heuristic analysis is used for antivirus detection in software, for usability assessment of computer interfaces as well as for solving many types of technical problems. For this study, the heuristic analysis of the two A3 engineering reports revealed engineers' investigative methods, including special topics of interest as well as heuristic question prompts used to uncover or generate special topics. Also, this heuristic analysis, conducted with Mervin's interpretive assistance, enabled me to better understand how these engineers learn problem-solving practices and contribute to decision making at Megalith.

Due to the exploratory nature of this research, I used grounded theory as my research method. Grounded theory begins not with a hypothesis of what I will prove (as in scientific method) but with data collection from mixed methods and resources where theory evolves over the course of the study (as in reverse engineering). Data collection from grounded theory consists

of mixed methods and resources, and this approach was consistent with how I understood learning to take place, where we seek and consider multiple perspectives and resources to make meaning. Aside from "capturing as much of reality as possible," the mixed method approach is beneficial because it allows for triangulation between methods as a means of "clarifying meaning" as well as "verifying the repeatability of an observation or interpretation" (Denzin, 2005, pp. 10 & 454). To select methods that would allow me to clarify and verify my understanding of workplace practice, I drew from Bazerman's (2002) ideas for micro-empirical study of workplace technologies, such as the A3 report. Bazerman (2002) suggests that due to the complex nature of workplaces “ethno-methodology, conversational analysis, and sociolinguistics" should be used to guide the study of situated technologies (p. 344). My methods included the heuristic analysis of Megalith A3 reports, through both textual analysis as well as a series of collaborative and interpretive interviews or discussions with the Megalith engineering manager

For the final phase of workplace study, I expanded my analysis by looking for patterns and counter-patterns of problem solving and decision making in different engineering workplaces. I engaged in multiple semi-constructed conversations with Mervin and two additional engineering managers to better understand issues related to workplace culture, report genre practices as well as rhetorical problem solving and decision making. The method scheme for these two stages of workplace study, which required the assistance of three engineering managers, is provided in Table 3.1 below:

Table 3.1
Workplace research study: mixed-method heuristic analysis of two A3 engineering reports (with additional interviews with engineering managers).

Sites:	Time:	Participants:	Recovery Methods:	Recovered Information:	Interpretive Methods:
Megalith Automotive Company	Spring 2011 Summer 2011	Mervin, engineering design manager	Phone interviews Clarifying Email discussions Participant review of interview summaries	Interpretation of completed A3 reports Situated workplace perspectives: (see below)	A3 Heuristic analysis in different contexts: - Rhetorical situation - Text and graphics - Special topics - Form and function - Delivery
Megalith Automotive Company Gamut Manufacturing Company Versatile Venture Company	Summer 2011	Three engineering managers: - Mervin with Megalith Company - Greg with the Gamut Company - Victor with the Versatile Venture Company	Phone interviews Clarifying Email discussions Participant review of and feedback for interview summaries and chapters 3 and 4 of this thesis	Situated workplace perspectives: - Cultures and systems - Rhetoric - Learning communities - Challenges of new graduates - Suggestions to students and faculty	Comparison between perspectives: - Identification of patterns - Identification of counter-patterns

Note: The contributions of research subjects were anonymous and pseudonyms are used for the names of engineering managers and their companies.

This initial phase of workplace study consisted of my own textual and graphical review of the A3 forms, followed by conversations (via phone interview and follow-up email) with Mervin. This study included the side-by-side analysis of the Complete A3 Report and an Incomplete A3 Report that provided an opportunity for deep understanding. During these conversations, I collected information that guided the ethno-methodological interpretation of the A3 forms as well as a sociolinguistic understanding of the workplace culture where these decision-making reports where created. Once my analysis was documented, Mervin reviewed and provided additional information to enhance the analysis. With my preliminary analysis, my mixed methods approach allowed me to develop an understanding of that workplace's practices through different and reiterative techniques for gathering-information. Yet, I was quite aware that workplace practices are sometimes transparent to those who employ them.

While the initial phase of my research provided valuable information about engineering problem solving at Megalith, my goal in this thesis research is to suggest ways to help undergraduates prepare for workplace problem solving, not just problem solving at the Megalith Company. In the final phase of workplace study, I expanded the scope of my project to include two additional perspectives from engineering workplaces. I emailed questions and then scheduled phone interviews and completed email exchanges with each manager. Through these in-depth, semi-structured interviews as conversations, researcher and research participants "co-construct a mutual understanding by means of sharing experiences and meanings" as a form of collaborative storytelling (Denzin 126). I documented my findings in case summaries, which were given to the respective engineering managers to review and revise in an effort to achieve sense making within the context of this thesis research.

I then triangulated the methods I used as a means of validating and noting variation in my data and analysis. "Triangulation is the simultaneous display of multiple, refracted realities" that invites the researcher to "explore competing visions of the context, to become immersed in and

merge with new realities to comprehend" (Denzin, 2005, p. 6). Through triangulation of A3 interpretive heuristic analysis, textual analysis and managerial interviews, I was also able to explore variables that could influence the substance and use of heuristics in different workplace locations and to expand my understanding of cross-discipline workplace practices. Triangulating also allowed me to compensate, in part, for my outsider status and lack of situated, technical and cultural expertise that typically will compromise the heuristic analysis of internal workplace discourse.

Location as Researcher

My role in this workplace research was as observer and interviewer. This workplace study and analysis provided me with a unique opportunity to understand how engineers consider rhetorical situation by drawing from an adaptable heuristic (means of inquiry and investigation) to deliver persuasive reports to a decision-making audience. My analysis also examined how engineers learn these practices.

Participants

When beginning the heuristic analysis of the A3 reports, I understood that I would require the expert assistance of others. Selber suggests that a heuristic analysis of existing documents and practices is particularly challenging because it requires a considerable measure of disciplinary knowledge and is best conducted with expert guidance (Selber, 2004, p. 131). I knew that I needed the analytical expertise of my professors and the technical and workplace expertise of engineers to support my analysis.

I had chosen to study the domain of engineering because my own experience and understanding of engineering work would be useful for technical data collection and analysis. I drew from the experience and perspectives of engineering managers from three companies to support my analysis. I chose to interview engineering managers (not engineers) because managers' perspectives reflected experience in many roles that are important in the study of

engineering problem solving. For example, each manager I selected has experience as a consumer of engineered products, as an engineering student, as an engineer and as a manager, who has worked within (sometimes multiple) workplace systems and who hires and guides engineers in navigating workplace systems. Each manager had a bachelor's degree in mechanical engineering, a master's degree in business administration (MBA) and/or engineering and over twenty years experience as an engineer or engineering manager. To keep the identity of companies and managers anonymous, I use pseudonyms for both the companies and the managers involved. Information about each manager is provided below:

Mervin at The Megalith Automotive Company

Mervin has worked as an engineer or engineering manager for three automotive companies. He is currently the manager of multiple engineering design groups with over 100 engineers at the Megalith Company. He has a bachelor's degree in Mechanical Engineering and an MBA.

He enjoys coaching engineers (novice and experienced) here in the United States and also enjoys working with engineers and managers at an other foreign locations to coordinate the manufacture of consistent quality products.

Greg from the Gamut Manufacturing Company

Greg has worked at the mid-size, Gamut Manufacturing Company since graduating with his bachelor's degree in Mechanical Engineering. He spent six years working in product cost and quality and three years in program planning. For the past 15 years at the Gamut Company, he has been an engineering manager with teams of up to 30 people that worked on very large programs to introduce new products. More recently he has managed teams that work in the model shop to develop product prototypes. Greg also has an MBA.

Greg enjoys his role as a manager because he finds it rewarding to mentor, coach and provide opportunities that allow engineers (whether novice or experienced) to continue to learn, grow and develop their expertise.

Victor from the Versatile Resources Company

Victor is managing partner of a venture capital and entrepreneurial management firm that provides investment capital and operational management to early stage companies. He has worked for two automotive companies and has held senior operating positions and/or board positions with seven early stage companies. Victor has an undergraduate degree and a Master of Science Degree in Mechanical Engineering as well as an MBA.

Victor enjoys the versatility of his work and also his engagement with very talented and creative engineers and inventors. Victor typically works with self-directed, mid-career engineers, and these engineers are always highly effective, specialized, versatile and experienced.

These managers had experience managing design engineers, which made triangulation of findings very useful because design engineers work extensively across organizational structures to ensure that their designs can be implemented. Two of the participating managers currently work for companies that manufacture well-known consumer products. The third manager, besides having experience engineering consumer products, is currently the co-owner of a venture capitalist company and serves as engineering manager for start-up engineering companies.

Methods

By triangulating methods, I drew from over 15 pages in transcribed notes from A3 report heuristic evaluation with one manager, three managerial interviews as well as email exchanges so that I could identify consistencies and inconsistencies across a sample of engineering cultures. My workplace research began as part of my final project for Dr. Marika Seigel's HU6115: Science and Technology in Contemporary Rhetorical Theory course in the Spring of 2011.[2] My class had been studying rhetorical theory, and I contacted Mervin to get a better understanding of the engineers' use of rhetoric in workplace problem solving. In Mervin's replies to my initial questions (Appendix A), he mentioned how his company's engineering managers rely on engineers' A3 reports to make decisions. Mervin provided me an A3 template and two A3 reports for analysis, including one engineer's complete report and another engineer's inadequately constructed and incomplete report, which included Mervin's suggestions and questions to the engineer. These reports were unique because they illustrated not only the engineers' use of the A3 report form for influencing decision makers, which is considered an engineering industry standard, but also

[2] The project title for the initial part of this thesis research is called, "Addressing Expediency in the Executive Summary: An Interview with an Engineering Manager" (IRB#M0744)

included the manager's typed comments, which were intended to guide the engineer in learning Megalith's problem-solving practice.

When I received the reports, I was surprised by how the form design encouraged a rhetorical problem-solving approach. For example, the report fields included a purpose field and expected benefits, which prompt the engineer to consider the project's purpose and exigency from the perspective of audience. I drafted a list of questions about the A3 form and forwarded this to Mervin (Appendix B). From Mervin's interpretive replies, I sorted my findings into categories: rhetorical situation; text and graphics; special topics of inquiry; form design and function and persuasive delivery. While this analysis seemed to address the aspects of rhetorical practice evident in engineering problem solving, this analysis did not seem to reflect the culture where the A3 reports were created. For this reason, I conducted a phone interview, where I posed questions to explore how engineering disciplinary traditions and processes, as well as Megalith's work culture and institutional processes, contribute to the meaning of these reports (Appendix C).

From this interview, I developed a better understanding of Megalith's engineering problem assignments, customers, investigate practices, workplace systems, organizational structures, cultural practices, as well as collaborative and learning relationships. To triangulate my findings, I conducted phone interviews with two other engineering managers in the Summer of 2011, posing questions to better understand the situated nature of heuristics that contribute to decision-making reports (Appendix D).[3] In particular, these interviews provided a better understanding of how rhetoric plays a part in effective engineering, the influences of workplace culture on engineering and how engineers are mentored into a company's community of practitioners.

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[3] The project title for the second part of this thesis research was called, "Problem Solving, Participatory Learning and Rhetorical Communication Practices in the Engineering Workplace: Interviews with Engineering Managers" (IRB#M0808E).

Conclusion

This research provides me with findings that address the research questions I've identified to frame my investigation: How do engineers use rhetorical practices, culture awareness and technologies to support their engineering assignments? What rhetorical practices in engineering problem solving are particularly challenging for new engineers? How do engineers learn rhetorical practices in the workplace? While I learned a lot in my workplace research, this thesis will focus on findings that I feel are relevant to the undergraduate's preparation for workplace deliberative problem solving. In Chapter 4, I will present findings of the workplace research cycle, including the analysis of Megalith reports. I also demonstrate how rhetorical principles, cultural practices and technology politics are important for the deliberative problem solving that takes place within workplace systems. In Chapter 5, I present the engineering managers' recommendations to students and educators in the context of workplace problem solving.

Chapter 4

Understanding Engineering Problem Solving through the Heuristic Analysis of A3 Reports

Introduction

In this chapter I investigate my research questions: How do engineers use rhetorical practices, culture awareness and report technologies to support their engineering assignments? What rhetorical practices in engineering problem solving are particularly challenging for new engineers? How do engineers learn rhetorical practices in the workplace? As I began my workplace study, my research questions became investigative heuristics, leading to subsequent topics of inquiry, a dynamic investigation in keeping with the grounded theory approach and findings that enabled me to more thoroughly answer my research questions. This study investigated the rhetorical problem-solving practices in a manufacturing workplace through the interpretive heuristic analysis of A3 project planning reports, developed by two engineers for deliberative problem assignments at Megalith Automotive, an international company with engineering staff as well as manufacturing plants in multiple countries. Mervin, a design manager at Megalith Automotive, supplied three documents for this study. These documents include a Megalith A3 report template (Appendix E), a complete A3 report (Appendix F) that helped convince Mervin to approve the engineer's proposed course of action, as well as an incomplete A3 report (Appendix G) that provided insufficient information for decision making.

While Megalith A3 reports are ideal rhetorical artifacts for analysis, I realize the challenge of analyzing Megalith reports as an outsider. Gadamer (2004) suggests that when artifacts are

studied from outside the "written tradition of a culture," they become "dumb monuments," until the "context of a whole is understood" (p. 392). Mervin's interpretive assistance was essential and critical for my analysis of the A3 reports, which as rhetorical artifacts are best understood by a situated expert, who understands heuristics, has historical access, and who uses these rhetorical documents to make decisions (or act) within the situated culture.

For this reason, I draw from interview and email exchanges with Mervin to illustrate how Megalith A3 reports work as mindware technology alongside other cultural and disciplinary practices, such as mentoring, to help the engineer develop a flexible and adaptable rhetorical *technê* as well as generate and recycle engineering heuristics for rhetorical, deliberative problem solving. I analyze how Megalith uses A3 reports to guide engineers in addressing the rhetorical aspects of their projects and how engineers use A3 reports as rhetorical artifacts to influence decision making a means of appealing to ethos, pathos and logos to influence Megalith decision makers. The rhetorical analysis of Mervin's mentoring comments to the engineer suggest how the report fails to account for critical aspects of the rhetorical situation and to apply an appropriate heuristic, or path of investigation, which would have enabled Mervin to understand and approve the project.

This chapter is divided into three parts. First, I explore how the new engineers are introduced to Megalith culture and practice through orientation and Megalith's customized A3 report technology. Second, I suggest how the A3 report titles prompt engineers to conduct an analysis of the engineering project's rhetorical situation, which helps the engineer frame their investigation and design project plans. Third, I examine how Megalith engineers' A3 reports offer rhetorical appeals (ethos, pathos and logos), provide an opportunity for feedback, and facilitate management decision making.

Workplace Enculturation through Immersion and Megalith A3 Report Mentoring

For new engineers, who are unfamiliar with workplace and engineering problem-solving practices, conducting a rhetorical analysis and planning an investigation for rhetorical, deliberative problems is challenging because practices require an understanding of the context or workplace. Ethnographic studies in engineering workplaces suggest that new engineers need to increase their level of social cognition (to reflect the social environment or discourse community) to be successful (Winsor, 1996, p. 8). To problem-solve and communicate persuasively, activity awareness is essential. Activity awareness requires ongoing monitoring and sense making (Carroll, 2008, p. 1). New engineers entering the workplace participate in different types of enculturation practices that will help them gain activity awareness.

Enculturation through immersion is a particularly challenging practice at Megalith, an international company with several engineering and manufacturing locations. Regardless of their home location, new engineers at Megalith spend time at Megalith headquarters (HQ), where they immerse themselves in the Megalith HQ infrastructure, learn Megalith's development process, build relationships with their counterparts and other engineering experts and learn the nuances of Megalith engineering design. Mervin explains, "If the engineer goes (to Megalith headquarters) with an open mind, is proactive, works with people and adopts that culture, these engineers will gain much from the experience. If their main concern is to leave at 5:00 pm or if they wait at their desk for someone to tell them what to do, they will hate the experience." Engineers are strongly encouraged to form trusting social bonds with engineering group members at Megalith HQ, who train them by offering tribal knowledge, which would consist of the unwritten, historical, and shared understandings of community or sub-community.

When Megalith engineers return from Megalith headquarters to their engineering groups, they are assigned exigent engineering assignments that provide opportunities for rhetorical *praxis*. With each new assignment, Megalith engineers are expected to conduct an initial investigation, develop a project plan and submit these plans in the form of A3 reports to decision makers, including department managers such as Mervin, for review and approval. Megalith department managers, group managers, and team leaders rely on concise engineering A3 reports to manage dozens of concurrent engineering projects to support product development for Megalith vehicle product lines. In turn, Megalith engineers use the company's A3 report templates as a rhetorical artifact to persuade decision makers (management) to approve their plan and budget.

Companies and other institutions customize their A3 templates to frame their organization's preferred investigative (heuristic) and problem-solving methodology and to encourage awareness of organizational activities and perspectives that play a role in workplace decision making. Customization will take many forms. For example, Megalith has customized the paper size of the report by electing to use the more convenient A4-size (approximately 8.5 by 11 inch) paper instead of the A3-size (approximately 11 by 17 inch) paper. These A4-sized reports, used at Megalith and many other companies, function similarly to A3-sized versions. Yet the term "A3 report" is widely recognized and understood, and for this reason I refer to Megalith's A4-sized report as the Megalith A3 report throughout this thesis.

Most institutions' A3 reports typically consist of only a single project overview page. This form design encourages the engineer to be concise and judicious when delivering information and conveying ideas. In contrast, Megalith's template design is expanded to three or more pages, including a cover page, a project overview page and supplementary pages. Yet, the report's focus continues to be the "project overview" page, which is the second page, shown below in Figure 4.1.

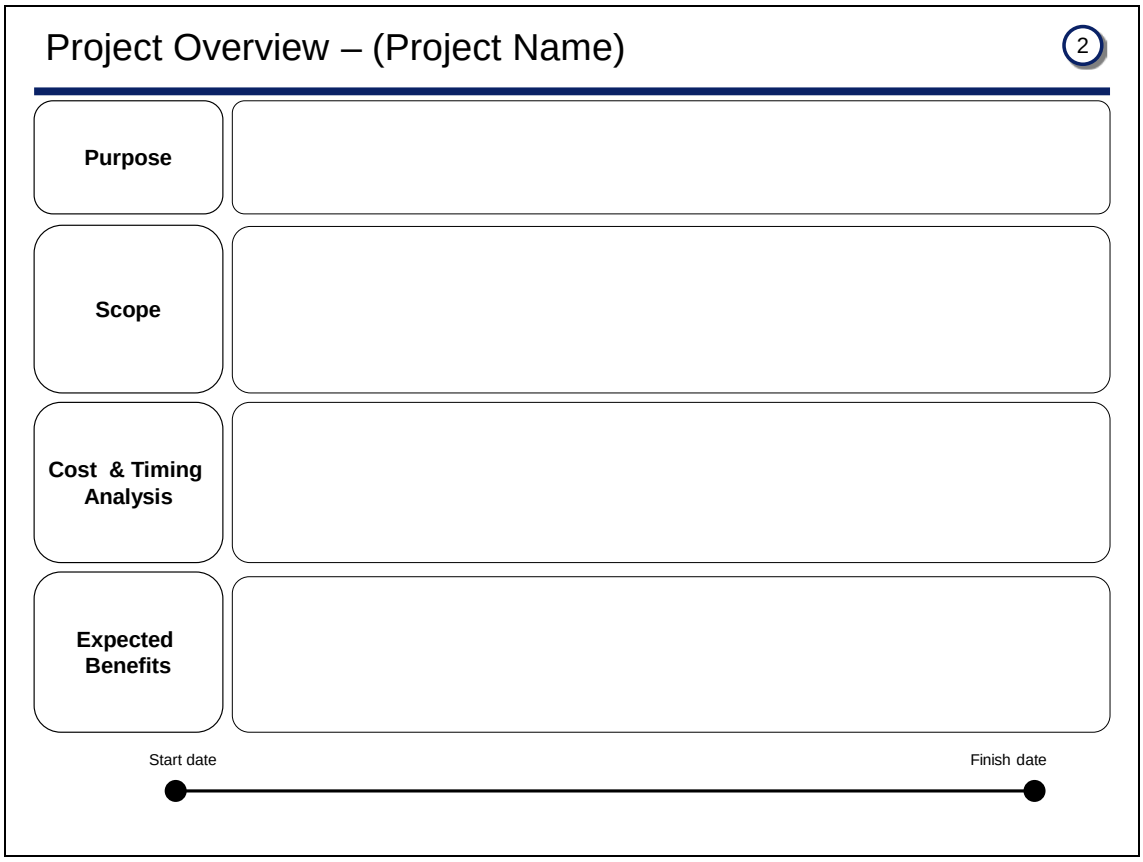

Figure 4.1. Blank project overview page of the Megalith A3 report template. Engineers are expected to use this template to present their investigative project plan to decision-making management for review and approval.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

Megalith's A3 project overview page is deceptively simple, only consisting of a series of boxes. Yet, the engineer provides a wealth of information for decision makers in these boxes, including description of current problem situation, goals and desired outcome, analysis, proposed course of action, and expected benefits of this course of action.

Megalith's A3 reports are particularly well suited as mentoring tools within the Megalith culture because they enable experienced engineers and managers a centralized means of

helping engineers develop a rhetorical *techné*, or flexible and adaptable technique for rhetorical problem solving, through engineering rhetorical *praxis*. Engineers are expected to document their emerging project ideas and plans and then convey their understanding of the rhetorical situation (exigence, audience needs, and constraints) on A3 report drafts. These drafts provide an encapsulated view of their project plans-in-progress, which are used when engaging with Megalith engineers in several contexts. For example, the engineer shares A3 drafts during daily or weekly status meetings with team leaders and group managers, who often provide verbal feedback to expand and enhance initial investigative and project plans. In addition, engineers are expected to seek assistance about technical issues and internal processes from people across the organization and use drafted A3 reports to help others understand their project plans and questions. Once A3 planning reports are developed, engineers submit their A3 project plans for review and budget authorization, department managers provide feedback and approval, and other Megalith employees use these A3 reports as reference documents when implementing project plans. Once the project is complete, the engineer submits a final A3 report with a full technical report to managers for approval.

The A3 Report Template for Planning a Rhetorically Situated Investigation

Mervin's interpretation of the A3 template fields as well as his feedback to his engineer suggest how the A3 template serves as a recycled heuristic to help uncover special topics and common topics that lead the engineer to address project assignments as rhetorical. With special and common topics of importance, the engineer can develop project plans, conduct an appropriate investigation, and engage in rhetorical acts that will contribute to decision making at.

Special topics are commonly accepted lines of reasoning that are special (or particular) to a community of practice that has a stake in the situated problem. To guide engineering design

that meets the needs of the society and users, different communities of practice (including governments, disciplines, industries and institutions) uphold the integrity of their own community by developing standard special topics for engineering problems. Institution specific special topics, such as vehicle and plant consistency, would reflect the practices of a particular institution's culture. Disciplinary-specific special topics, such as product durability, would include shared concepts within a particular disciplinary community. Government agencies, in turn, may impose special topics that reflect societal interests, such as emissions.

Special Topics and Implicit Heuristic Questions of the A3 Report Genre

Like other commonly accepted lines of reasoning, report genres reveal special topics of interest that reflect the communities (workplaces, disciplines and industries) where they are used. For new engineers, who are new to the Megalith and disciplinary communities and heuristic practices, the A3 section titles provide genre-specific special topics that represent a partial heuristic for developing investigative project plans.

The section titles of the A3 report comprise the special topics of interest that are unique (special and particular) to the A3 report genre, providing important frames or screens that help engineers understand situated project assignments. Kenneth Burke (1966) suggests that terms we use provide “terministic screens” that each of us has that allows us to make sense of the world around us (50). These screens focus our attention:

> Whatever terms we use, they necessarily constitute a corresponding kind of screen; and any such screen necessarily directs the attention to one field rather than another. Within that field there can be different screens, each with its ways of directing the attention and shaping the range of observations implicit in the given terminology (Burke, 1966, p. 50).

While Burke was not speaking of report templates specifically, his explanation applies well to A3 section titles, which prompt the engineer to report observations in congruence with an implied Megalith heuristic standard. Much like the abstract of an academic paper, specific types of

information and organizational schemes are expected in the Megalith A3 report to support communication, research, and decision-making activities within the organization. As the engineer develops an A3 report, these section titles become special topics that compel the engineer to inquire, investigate, and provide information in the context of the project assignment's rhetorical situation. The template may appear rigid and inflexible in its ability to meet the situated needs of particular assignments, but the engineer can chose which information to include and how to present this information in the document. For example, the engineer may use tables, lists and pictures and may adjust how text is stylized by adjusting size, font and weight. In addition, the engineer is invited to provide supplementary information on subsequent pages, in the form of inartistic proofs (such as data) and artistic proofs (such as interpretation), to support their appeal.

Heuristic questions related to the Megalith A3 report genre and engineering and workplace practices are implicit, and Megalith engineers develop a rhetorical *techné* for recycling and generating heuristics through mentoring with experienced engineers and managers. During my interviews with Mervin, he revealed implicit A3 report heuristic question prompts. In Appendix E, I include the Megalith A3 report template with heuristic questions included in Mervin's words in green type. My analysis of the template is presented linearly, beginning with the cover page. The A3 template fields are ordered to promote usability for Megalith decision-making audiences. Yet, this order is not intended to imply a linear process for the engineers' investigation and analysis.

Cover Page of the A3 Report Template

In most workplace contexts, engineers are successful when the decision-making audience acknowledges the engineer's work as a valuable contribution to product development. The engineer must consider the project type and title, report type, and the audience, all of which help the engineer determine the needs of decision-making audiences. Mervin observes that Megalith does not set the process of investigation, but instead sets the project goals, audience and report format. The engineer acknowledges this information, beginning on the report cover of

the Megalith A3 report template, as illustrated by the following cover page of Megalith A3 report template (Figure 4.2).

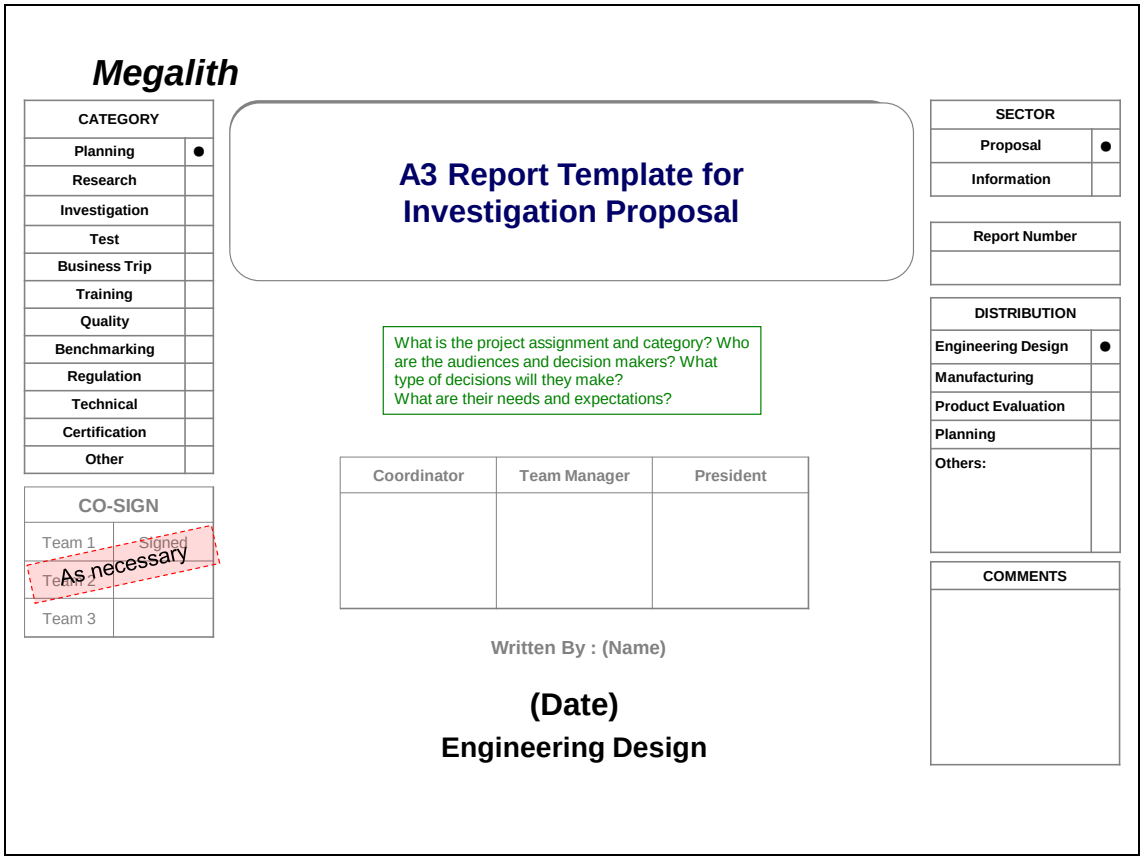

Figure 4.2. Cover page (page 1) of Megalith A3 report template with implicit instructions added in green type in Managers own words.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

Due to the complicated, integrated systems that are inherent in automobiles, Megalith projects involve deliberative problems with a narrow focus. The Megalith engineer might be asked to investigate a new technology, establish a Megalith standard specification, or address a manufacturing problem that will be used to enhance products. By considering project title, type

and audience and referring to examples of past reports and projects of this type, the engineer will better understand why the project has been assigned.

Throughout the course of their project Megalith engineers develop several reports, which include two rhetorical A3 reports for different decision-making audiences: the A3 project proposal and the final A3 project report. At the beginning of the project, an A3 report is used to persuade department leaders to approve his/her particular engineering project proposal and to grant budget usage authorization. As the engineer is developing A3 project plans, senior engineers (with technical and process expertise), team leaders, lead engineers and group managers review and rely on A3 reports to coordinate efforts between projects and people and communicate status to department managers. After the A3 project proposal is drafted, submitted, revised (as necessary) and approved by the department manager, additional approval may be necessary. For projects that are over $100,000, upper management must approve the A3 project plans. If projects are cooperative efforts between departments or Megalith locations, A3 project plans are shared via email memo for approval.

Once approved, the engineer implements the approved plan, which for a design engineer might include obtaining vehicle structures or developing prototypes and coordinating the testing and validation of these components. At the end of the project, the engineer develops a final A3 report, which summarizes findings and proposes next steps. The final A3 report is submitted as part of the final project report, which also includes a full report of findings and an appendix with detailed data charts and tables. The group leader and department manager will review all parts of the final project report, and the vice president and other applicable management will read at least the A3 report.

Understanding the needs and expectations of audience and stakeholders is critical for effective engineering problem solving and reporting. Megalith engineering managers, who have engineering expertise in workplace contexts, rely on the concise A3 reports to understand the

engineers' interpretation of the problem, investigation path, and proposed plan, so that they can efficiently make decisions and coordinate concurrently deployed projects. This concise format suits the needs of Megalith management, especially vice presidents who receive A3 reports from fifteen departments and three hundred engineers.

Both project planning and final versions of Megalith A3 reports are investigative-style reports, which require the engineer to research problem and possible solutions prior to proposing a course of action. "On the basis of the information gathered and (evaluated), the investigative report answers the question of whether something can or should be done or which course of action is the best" (Rude, 1995, p. 191). Investigative reports often present recommendations without particular detail, but this characteristic is not applicable to Megalith A3 reports, which present a juxtaposition of text, tables, graphs, illustrations and photographs that provide important detailed, technical pieces of information. In Megalith project proposal reports, the engineer's purposeful presentation of this seemingly fragmented information leads to managerial decision making that denotes rhetorical action.

Due to Megalith management's reliance on the engineer's perspective and proposed suggestions to make decisions, the engineer is expected to address the rhetorical situation when working on project assignments. In other words, the engineer must meet the needs of audience, plan and conduct a project investigation, and influence decision making by proposing a course of action. The elements of the Megalith A3 report template represent a partial heuristic intended to prompt engineers to examine the rhetorical situation of their assignments.

Project Overview Page of the A3 Report

The "project overview" page (see Figure 4.3), which is the second page of the Megalith A3 Report Template (Appendix A), is the page most often associated with A3 reports.

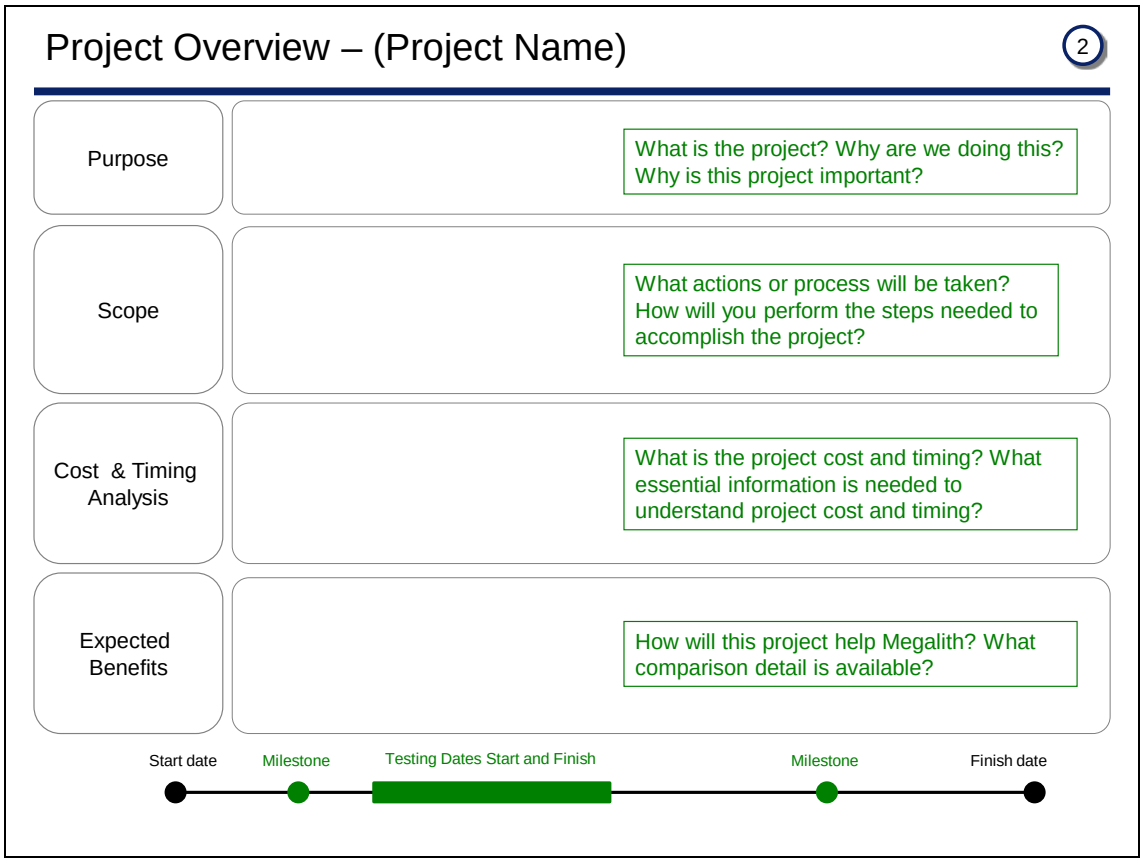

Figure 4.3. Project overview (Page 2) of Megalith A3 report template with implicit instructions added in green text in managers own words.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

The engineer must understand the project assignment in the context of both end-user (vehicle owner) and Megalith goals in order to develop an investigative plan that meets these needs. Megalith projects address goals that involve developing innovations, improving quality, designing new products and supporting other company goals, which are institutional objectives ultimately intended to address or shape vehicle owners' needs and wants. Megalith special topics of interest are associated with each goal. For developing innovations, engineering departments focus on special topics that include investigating new technologies in the marketplace or inventing new technologies. For improving quality, engineering departments focus on special topics that include providing manufacturing plant support and supporting continuous life-cycle improvement. For designing new products, engineering departments focus on special topics such as improving styling. To support company goals, engineering managers identify suitable special topics of interest to achieve those goals. For example, if the company goal is to reduce warranty costs, the manager may establish an objective to study warranty costs and propose solutions for reducing them.

Department managers, who are responsible for specific vehicle product lines, work with company stakeholders and engineers to identify and prioritize project possibilities aimed at meeting Megalith special topics of interest. Megalith Automotive designs products with very complex and extensively integrated systems, and as a result, engineering projects tend to be narrow in scope, focusing on an aspect of a system, a vehicle or a product line. For example, a project may focus on brake pads.

Department managers distribute projects to group managers, who in turn assign projects to engineers. Mervin from Megalith Automotive explains, "Continuous improvement is key to (Megalith) success, so engineers are regularly assigned projects for their systems to develop new technology, improve quality and performance." At this stage, project assignments consist of a brief description as well as a few qualitative investigative requirements, which will vary in their

specificity. Engineers are then responsible for investigating the viability of project assignments and advising department managers with a proposed course of action (often a project plan) using the A3 report template.

Once engineers receive their project assignments, they must conduct a rhetorical analysis to identify essential information about the problem, decision-making audience and initial constraints, which will shape the investigative plan and opens up the possibility for innovation. Engineers, then, employ rhetorical practices as “a means not just of presenting the results of inquiry effectively (persuasively) but also of conducting the inquiry" (Rude, 1995, p. 195). This analysis helps the engineer frame the investigation, which will include investigative topics and categories of interest (special topics), project requirements (common topics or constraints), project activities as well as resources for the engineering assignment.

The engineer is then able to develop a project plan. On the Project Overview page of the A3 report, engineers present recommendations and useful project plan details in the "purpose," "scope," "cost and time analysis" and "expected benefits" fields. This information is intended to provide management concise yet clear information to make decisions about their engineering projects.

Supplementary Pages of the A3 Report Template

While the fields of these reports point to the type of information needed by decision makers, these reports also offer engineers flexibility for presenting their plans and for providing supplementary information. For example, the Megalith A3 Report Template (Appendix E) also includes a template for "supplementary information" pages (Figure 4.4), which invite engineers to provide additional information for decision makers.

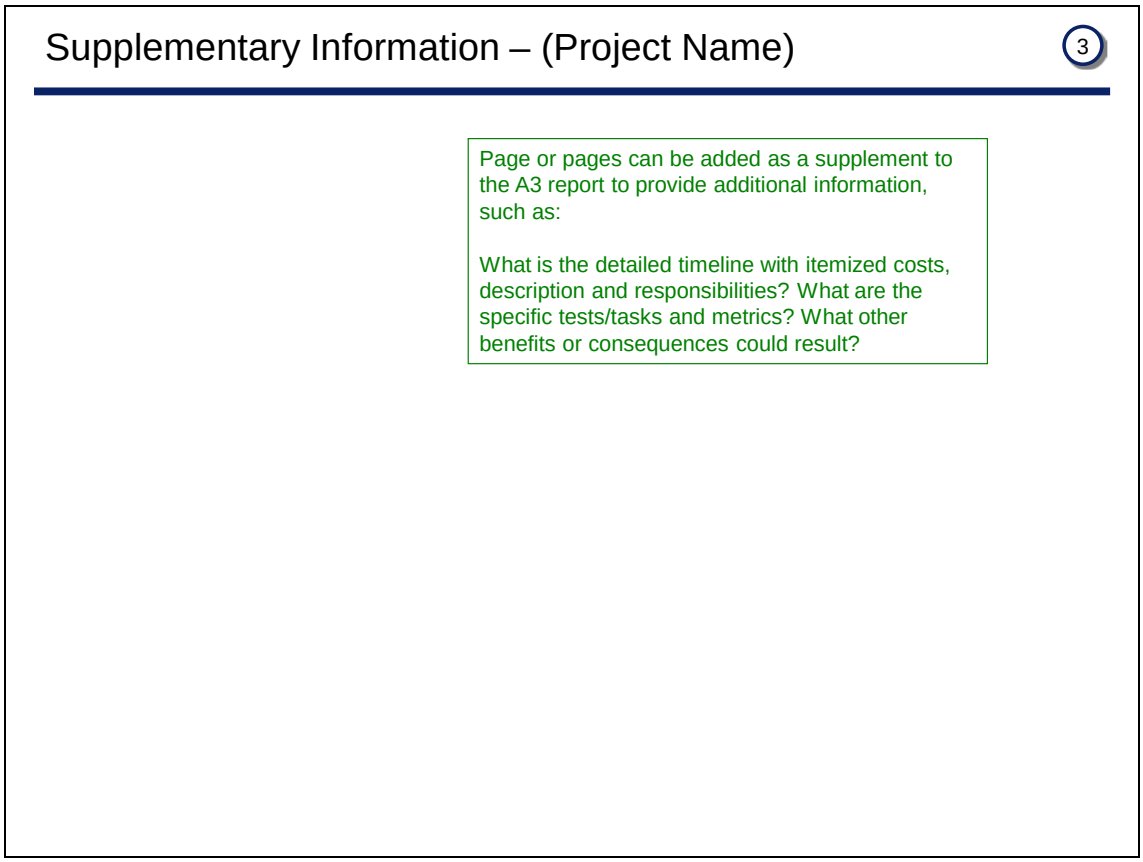

Figure 4.4. Supplementary information (page 3) of Megalith A3 report template with implicit instructions added in green type in managers own words.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

Megalith engineers can use Supplementary Information pages to provide decision makers with additional information to support their project plans or to meet expectations of a specific decision-making audience. (Refer to Appendix F: Complete Megalith A3 Report for examples.) Engineers use these pages to appeal to ethos, pathos and logos as a means to influence and inform decision making. For example, these pages may present historical Megalith information applicable to the assignment or could include strategically constructed program timing Gantt charts and task charts that outline itemized costs, descriptions and responsibilities. The

number of supplementary pages that the engineer uses will vary, depending on the complexity of the project, the urgency in sharing plans, or perhaps the political ramifications of the project.

Heuristic Questions Associated with Megalith A3 Template Fields

Megalith engineers use A3 reports as rhetorical tools for planning and as rhetorical artifacts for presenting project plans at Megalith. In the context of engineering problem solving, the section titles of A3 reports represent explicit special topics of importance for planning and reporting. These section titles, as well as the corresponding implicit and recycled heuristic questions (explained by Mervin and shown in green type in Figures 4.2, 4.3 and 4.4), inspire investigation of rhetorical situation by providing a heuristic frame. The rhetorical situation would include an exigency (urgent problem), audience that can be persuaded through discourse to act, and "persons, events, objects and relations that ... have the power to constrain" (Bitzer, 1968, p. 8). Megalith A3 report genre special topics and recycled heuristic questions prompt engineers to identify additional special topics relevant to rhetorical situation and to generate new special topics and heuristics to suit the engineering assignment. Report special topics, implicit heuristic questions and aspects of rhetorical situation are illustrated below in Table 4.1:

Table 4.1
Rhetorical aspects of the A3 report template.

A3 pages	Section	Implicit heuristic questions revealed by the Megalith manager	Understanding of rhetorical situation
Report Cover - page 1		What is the project assignment and category? Who are the audiences and decision makers? What type of decisions will they make? What are their needs and expectations?	Audience
Project Overview - page 2	Purpose	What is the project? Why are we doing this? Why is this project important? What comparison detail is available?	Exigency; problem
	Scope and/or Plan	What actions or process will be taken? How will you perform the steps needed to accomplish the project?	Constraints and contingencies; topics of inquiry
	Cost and Timing	What is the project cost and timing What essential information is needed to understand project cost and timing?	Constraints and contingencies; topics of inquiry
	Expected Benefits	How will this project help Megalith? What alternatives have been considered?	Exigency; problem
Supplementary Information - other page(s)		What additional information is needed to understand project overview? What is the detailed timeline with itemized costs, description and responsibilities? What are the specific tests/tasks and metrics? What other benefits or consequences could result?	Audience; substantiate constraints, contingencies and topics of inquiry and corroborate ethos, pathos, logos

Source: Created by Jean DeClerck

While section titles and heuristic questions are critical for developing an investigative plan, the A3 template is not a formulaic or procedural tool for designing the project plan. Section titles, as special topics of consideration, "prompt thinking through the project before the research begins," to discover relevant factors that will facilitate persuasion (Rude, 1995, pp. 189, 194 & 196). These section titles and corresponding heuristic questions above help guide engineers in rhetorical analysis of their problem assignments to identify disciplinary-specific, workplace-specific and problem-specific special topics and corresponding common topics.

The engineer translates special topics into detailed often-quantitative engineering requirements (common topics). Depending on the type of project, the engineer will use engineering requirements either as specifications (objectives and constraints) to design or as performance metrics analysis to evaluate. Engineers will include applicable standards, such as government safety standards, discipline standards for validation and Megalith specifications. Special topics, common topics and heuristic questions for a project become a heuristic, which can be recycled and customized as necessary for future problem assignments. The engineer pursues different solutions, evaluates them against the established engineering requirements and then chooses the option that makes the most business sense and will make Megalith most successful. Once the optimal solution is found, the engineer continues to identify technical specifications for the optimal solution.

By applying heuristic questions associated with A3 section titles, the engineer investigates problems as rhetorical (acknowledging audience, exigency, problem and constraints), as contingent (addressing special topics and common topics of interest) and as deliberative (reflecting multiple strategies for addressing these topics). Investigative plans developed through consideration of rhetorical situation, special topics and common topics will convey the ethos (credibility), pathos (emotional commitment and interest) and logos (logic, reason and creative order) necessary to influence and persuade decision-making management.

The "Five Whys" for Revising and Generating Heuristics

As drafted A3 reports evolve, the mentors' face-to-face interactions are frequent to help the engineer form plans. The mentors' questions will reflect the engineer's decisions from discipline-specific or workplace-specific perspective. The choice of mentoring questions will vary, depending the project type as well as the completeness of the engineers' A3 reports. When meeting with engineers, Megalith lead engineers as well as group and department managers employ Toyota's "Five Whys" questioning approach, a mentoring approach used to guide engineers in technical aspects of their work and to help them identify and resolve possible project problems. For example, when discussing a proposed plan, engineers might be asked to explain why the project was assigned or why the engineer chose each plan element was chosen. After the engineer's reply, the team leader or manager would ask "Why...?" and this exchange would be repeated for a total of five times to verify if the engineer understands and has thoroughly investigated the project assignment.

In employing the "Five Whys" questioning technique, mentors encourage engineers to examine and deepen their understanding of rhetorical situation because these questions force engineers to think about needs of people and the constraints and abilities of workplace systems where their engineering projects will be implemented. Mervin feels that mentoring engineers in their use of A3 reports through open-ended "Five Whys" (and not leading questions like "Did you consider ____?") forces engineers to "think by themselves, allowing engineers to assume more responsibility quicker."

Drawing from discoveries made during mentoring, engineers expand their investigative strategies. For example, they may seek technical details from vendors, benchmark other product applications, talk to Megalith senior engineers to determine validation tests needed, communicate with internal engineers to determine manufacturing feasibility and projected production rates, and read industry newsletters. In addition, the engineer may seek the expertise of other internal

departments (including Accounting and Material Group). Once engineers identify special and common topics, they develop their investigative plans and carefully present these plans on their A3 reports.

Delivery of Influential A3 Reports

Megalith engineers and managers will probably not use terms like "rhetoric" or "rhetorical" when describing their work. Yet, Mervin's interview suggests that experienced Megalith engineers and managers understand how their actions and their use of A3 reports work rhetorically, enabling them to understand their audience, investigate and persuade their audience to consider and accept their ideas and perspective. By addressing their assignments as rhetorical, engineers are able to contribute actively to the decision making taking place. Mervin finds that while the mentoring culture at Megalith is effective for developing project plans, new Megalith engineers are challenged to develop a brief account in the A3 report that anticipates management (audience) needs. Mervin explains, "If the (A3 report) does not have the appropriate information, the engineer probably does not understand the audience. Engineers get lost. They have all the details in their head. They forget their audience." Megalith goes to great lengths, through formal training and persistent mentoring of A3 use, to encourage engineers to collaborate with experienced engineers to understand their decision-making audience. Collaboration is considered to be a key factor in successful engineering work at Megalith.

Decision-making audiences (managers) expect the A3 report to be a brief, strategically specific summary that will inform and influence their decision making. When engineers fail to seek assistance from peers to understand the implicit needs of management, they may incorrectly assume that the A3 is like other types of technical summary reports that call for a version of technical information that offers simplicity and clarity to those who lack situated expertise. Yet, all Megalith engineering decision-making audiences, including the vice president, are highly

experienced engineers, with specialized technical expertise and workplace cultural knowledge. Mervin wants his engineers to consider, “What information is the manager going to think is pertinent." Megalith managers will need to know why the project is important, how the project will be executed and what results are expected so that they can efficiently make decisions and coordinate concurrently deployed projects. To ensure that their contributions will influence decisions taking place, the engineer references special topics that are of known or anticipated interest to Megalith and provides project plans and requirements (common topics) in sufficient detail.

Due to the critical role of Megalith A3 reports for product planning and manufacture, Megalith uses A3 reports as a collaborative and learning tool for mentoring novice engineers. This practice is not uncommon. A3 reports encourage problem solving in the context of social workplace systems and, for this reason, serve as learning and mentoring tools to guide the engineer through problem analysis practices of an organization (Shook, 2009).

New engineers meet daily with experienced Megalith engineers, team leaders and/or group managers to share their project plans and receive feedback. When these A3 reports are fairly well developed, reports are shared with department managers such as Mervin, who are an important decision making audience. These managers review engineers' A3 project plans and may request additional information before deciding whether to approve the engineer's project plan. To help me understand the expectations of Megalith decision-making audiences (such as management) and the challenges that engineers may experience in completing A3 reports, Mervin provided for my analysis two examples of his engineers' A3 planning reports: a Complete Megalith A3 Report (Appendix F) and an Incomplete Megalith A3 Report (Appendix G).

These reports are particularly useful for analysis because they capture any mentoring activity that takes place between Mervin and each engineer. Mervin receives and reviews each engineer's A3 reports online and, when necessary, adds and returns typed comments (in red) to

these electronic reports. In the Incomplete Megalith A3 Report (Appendix G), Mervin's comments reflect deficiencies that required this engineer to extend investigation and revise plans so that Mervin could decide whether to proceed with the project. In contrast, the Complete Megalith A3 Report (Appendix F), of which Mervin found no deficiencies, provides an example of how an engineer might provide brief, detailed information that enables informed decision making. My analysis, conducted with Mervin's interpretive assistance, revealed that engineers must explicitly convey their perspective by suggesting expected benefits in the context of Megalith special topics of interest, defining requirements using common topics, and providing plan details that reflect timing, resources, and approach.

Purpose Field of the A3's Project Overview Page

Engineers will use both the "purpose" and "expected benefits" fields to explicitly convey the project exigency in the context of Megalith special topics of interest (goals). In the "purpose" field of the Megalith A3 Report Template (Figure E.2 and Figure 4.1), the engineer describes the project in a way that emphasizes the exigency (urgency and importance) of this project in the context of the Megalith goals and special topics of interest. For the "purpose" field, the engineer addresses the following heuristic questions: What is the project? Why are we doing this? Why is this project important? What comparison detail is available?

The approaches used in the compete report and incomplete report are very different. In the "purpose" section of the Incomplete Megalith A3 Report (Figure 4.5), the engineer has failed to describe to Mervin the project's value (or insignificance) for addressing Megalith goals:

Purpose	• Investigate new technology: Adjustable Exhaust Valve (currently used by CARCO A and CARCO B) • Device purpose: -Reduce noise (provide damping to reduce resonance) -Allow smaller muffler – reduce weight (up to - 30%) -Reduce cost of exhaust system (- $ TBD) • Reduce noise by some expected amount? • How does it allow a smaller muffler? • Expected cost reduction amount? • What specific competitive vehicles will be used?

Figure 4.5. "Purpose" field of incomplete Megalith A3 report. The manager's comments suggest how the engineer fails to explain the project or reveal exigency in completing this project.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

This purpose statement in the incomplete Megalith A3 report demonstrates that the engineer has not yet fully investigated this project's importance for Megalith. Mervin expects the engineer to draw from a preliminary investigation of the valve and current Megalith vehicle to convince Mervin on the usefulness of this project. In his comments to the engineer, Mervin expresses his expectation that the engineer include comparison data (the valve supplier's quantitative noise data) that would point to benefits of this valve. In addition, Mervin expects the engineer to include persuasive elements of the project plan, including type of Megalith vehicle and anticipated cost savings. Ultimately, the engineer has failed to persuade Mervin on a proposed course of action. While the engineer will typically write a purpose statement to convince the manager to proceed with the project plan, it is important to note that the engineer could have advised the manager that the project would not support Megalith's goals.

In the "purpose" field of the complete Megalith A3 report (Figure 4.6), the engineer effectively conveys both exigency and benefits:

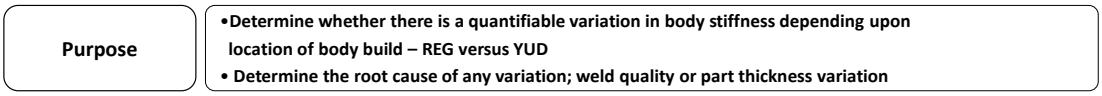

Figure 4.6. "Purpose" field of complete Megalith A3 report. This engineer conveys the exigency of this project assignment by noting Megalith special topics, resource details and kairotic potential.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

This engineer's statement is brief and may seem inadequate for inspiring *dunamis* (action) in the decision-making audience. Mervin, an experienced engineer and manager within the Megalith culture, found this engineer's project purpose summary to be very informative and influential because the engineer's report is strategically composed and arranged to accommodate Mervin's needs as decision-making audience. With Mervin's interpretive assistance, I discovered how the engineer's careful inclusion of text introduces the project plan within the context of special topics of interest, performance metrics (common topics) and kairotic potential that are particularly relevant to Megalith strategic goals.

To suggest how this project will benefit Megalith, this engineer includes project goals that correspond to two engineering special topics, vehicle and plant consistency, which support Megalith emphasis on improving quality. Vehicle consistency between plants is the focus of the first bulleted statement, where the plant locations (identified through the acronyms REG and YUD) are clearly identified. The second bulleted item suggests that variation between vehicles is also important. In addition, the engineer has defined specifications and performance metrics, using common topics, to the extent possible. For example, the engineer specifies that body stiffness variation will be examined in many body build locations and will be compared against Megalith standards to determine unacceptable variation.

Interestingly, to emphasize the urgency of this project, the engineer suggests the potential for discovering kairotic moments when he states, "Determine the root cause of any variation." Here the engineer suggests that this project may reveal additional exigent issues, which will become additional kairotic opportunities of interest to Megalith management. More importantly, the engineer assures Mervin that he will respond to any exigent, kairotic opportunity that emerges by investigating and proposing courses of action to address these emergent issues.

Expected Benefits of the A3's Project Overview Page

The "purpose" section of the report will suggest the exigency of the problem for Megalith. In the "expected benefits" section, the engineer is expected to expand upon the "purpose" statement to clarify the exigency of this project. In this field, the engineer is expected to explain how this project will be beneficial to Megalith as a way to accomplish company goals.

In the incomplete A3 report (see Figure 4.7), the engineer has included, not "expected benefits," but "expected result":

Expected Result	• Objective performance data for current system vs. proposed system • Detailed estimates for weight and cost savings • Project Budget $14,800, Timing ~ 10 weeks • What are the performance data for current system?

Figure 4.7. "Expected Result" field of the incomplete Megalith A3 report. The engineer fails to include well-defined requirements that would have conveyed the exigency of this project. The manager provides feedback in red type.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

In this section, the engineer fails to adhere to section titles presented in the Megalith template and, in doing so, fails to meet content expectations for A3 report. The engineer is expected to explain the anticipated benefits of this project in the context of Megalith's special topics of interest. Yet, the engineer chooses to present a vague project description, without references to

special topics and without requirements and performance data, described using common topics, such as size (for valve dimensions) and comparison (performance characteristics and cost of currently used valve versus proposed valve) and degree (such as weight). As a result, the engineer's references to project description, total budget and project duration do not explicitly convey whether implementing this project plan would be beneficial, detrimental or inconsequential to helping Megalith meet its goals. In failing to provide this analysis and recommendation, the engineer misses a kairotic opportunity to influence and contribute to decision making. As manager, Mervin needs to decide whether to proceed with the project and will conduct the analysis of expected benefits by himself if necessary. In order to anticipate the benefit to Megalith, Mervin will need performance data for Megalith's vehicle, which he requests here, as well as the claims of the valve supplier, which Mervin requested in the "purpose" section of this A3 report.

In the complete Megalith A3 report, the engineer includes several important benefits in the "expected benefits" field (Figure 4.8).

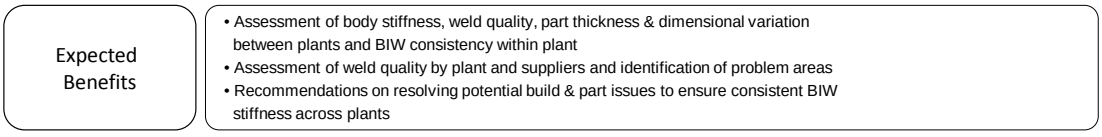

Figure 4.8. "Expected Benefits" field of complete Megalith A3 report. The engineer includes detail that convincingly informs the managers of the plan's potential.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

The statements included here are very persuasive to Mervin. The engineer includes not only the engineering special topics of vehicle and plant consistency but also the intention to evaluate and propose solutions to address any quality problems that this project investigation reveals. The engineer provides a comprehensive list of characteristics that will be assessed and specifies the extent that variation will be tested (between vehicles at the same plant and between plants). Perhaps most importantly, the engineer who presented this complete A3 report is very explicit in his commitment to provide "recommendations on resolving potential build & part issues to ensure consistent BIW stiffness across plants." In this statement alone, the engineer appeals of ethos (credibility), pathos (emotional fervor) and logos (logic) and inspires *dunamis*, which leads to Mervin's prompt approval of this project plan.

Project Scope of the A3's Project Overview Page

In the "scope" field of A3 reports, Megalith engineers are expected to present a project plan that includes activities that are used to either design or evaluate in the context of the engineering requirements. Engineers are expected to present information that will convince decision makers that the project plan's implementation will result in the expected benefits noted above.

In the "plan" field (Figure 4.9) of the incomplete Megalith A3 report, the engineer does not explicitly described the project plan:

Plan	• Adjustable exhaust valve technology attenuates exhaust noise, allowing for smaller, lighter muffler and/or resonator • Utilize Megalith product as demonstration platform for this technology • Megalith to provide vehicle and two stock exhaust systems to ACME for 10 weeks of development • Project Plan: 1) analyze the systems and simulation 2) re-design muffler system 3) build prototype 4) bench test 5) vehicle test 6) report 7) demonstration • No brief explanation on how the new valve works or type (e.g. butterfly valve controlled by the ECM based on engineer rpm) •What performance metrics are we testing this technology against? (specific noise level and sound quality) • What test HMC specifications are involved? • How much does the current muffler system weigh?

Figure 4.9. "Plan" field (and manager's comments) of incomplete Megalith A3 report. The manager's comments to the engineer (in red type) suggest that the engineer has failed to provide sufficient project plan detail for the decision-making manager.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

Mervin's comments continue to reflect his frustration that the usefulness and potential benefits of the project cannot be determined. Mervin continues to comment on the lack of description and technical specifications that are associated with both the Megalith vehicle and this new valve. Identifying this information is essential before a plan can be introduced as an appropriate course of action, which is why Mervin doesn't reference the lack of detail provided in the numbered items under "project plan."

In contrast, within the "scope" field of the complete A3 report (Figure 4.10), the engineer presents a plan for evaluating technical specifications, including obtaining vehicles, and scheduling tests:

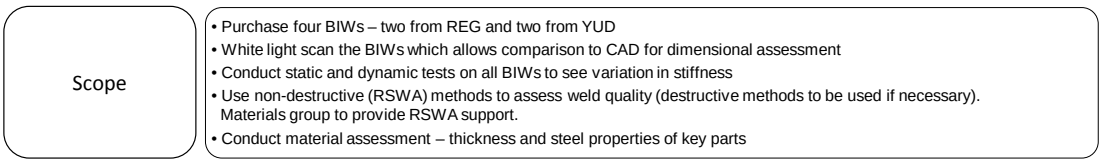

Figure 4.10. "Scope" field of the complete Megalith A3 report. The engineer provides extensive detailed information about vehicles to test, test descriptions and assessment methods.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

In this report, the engineer lists plans for evaluating the engineering requirements. For example, the "static and dynamic tests" will be used to evaluate "variation in stiffness." The engineer also provides definitions of tests that illustrate the soundness of this project plan. For example, the engineer explains "white light scan" as a test that "allows comparison to CAD for dimensional assessment." These details work rhetorically (persuasively) to assure Mervin that the engineer has developed a sound project plan.

Cost and Timing Analysis of the A3's Project Overview Page

Cost and timing are critical for managers, who coordinate and plan so that the resource needs are met for multiple simultaneous projects to support product development. Managers require detailed information about the timing of material resources, testing facilities and personnel. In the incomplete A3 example (Figure 4.11), the engineer fails to provide much data about cost or timing:

Figure 4.11. Missing cost and Timing information in the Megalith incomplete A3 report. Manager's comments to the engineer (in red type) suggest that the engineer did not consider the project coordination needs of the decision-making manager.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

Instead of explaining the resource and timing needs of the project in a section titled "cost and timing," the engineer only notes the projected project duration as "10 weeks" and places this information in the "expected result" field. In the incomplete Megalith A3 report, the engineer's exclusion of this information results in Mervin's comment that a detailed timeline is needed with key project milestones and timing. Pictures and timeline are provided in the complete A3 example (Figure 4.12):

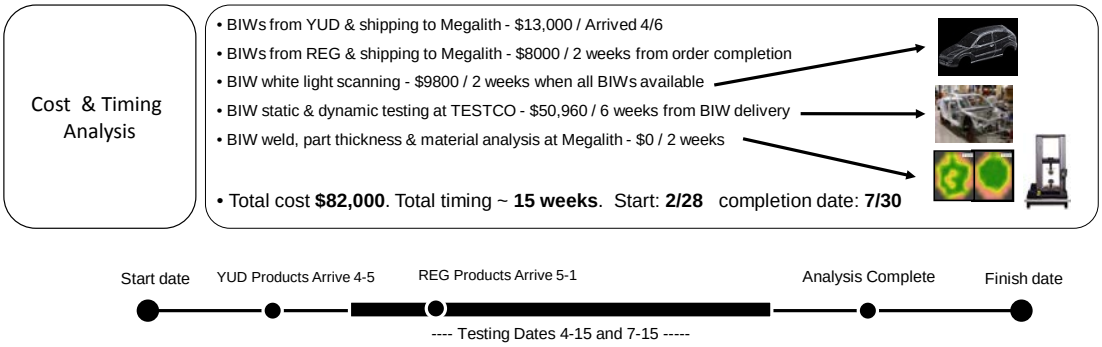

Figure 4.12. "Cost and Timing Analysis" field of the complete Megalith A3 report. The engineer provides detailed information about resource needs and timing milestones for Megalith decision-making audiences.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

This engineer provides detail and visual aids (pictures, test schematic, illustrations and timeline) to assist decision-making audiences in understanding the project plan. Throughout the interviews and email exchanges, Mervin noted the importance of pictures in A3 reports. He explained, "At (Megalith), pictures are worth a ton for people who speak a different language." Pictures make it simple for managers to quickly review and understand the project proposal. Effective (A3 reports) will include tables, graphs, and pictures, which simplify the story that engineers are trying to tell.

According to Mervin, after completing a few projects with the critique and assistance of mentors, new engineers "will understand the expectations and should be able to complete (A3 reports) in two or three iterations." Further, when engineers consider how their projects benefit Megalith in the context of Megalith's goals and objectives (or special topics of interest), they will be situated to recognize kairotic moments that can position them as vital contributors towards Megalith decision making.

Conclusion

Throughout this workplace study, I have investigated my heuristic questions: How do engineers use rhetorical practices, culture awareness and technologies to support their engineering assignments? What rhetorical practices in engineering problem solving are particularly challenging for new engineers? How do engineers learn rhetorical practices in the workplace?

This workplace research has revealed how Megalith engineers pursue innovative possibilities for deliberative engineering problems by engaging in rhetorical *praxis* with the mentoring assistance of experienced Megalith engineers and managers. Through *praxis*, Megalith engineers develop a rhetorical *technê*, comprised of flexible and adaptable approaches and techniques for addressing deliberative engineering problems at Megalith. As part of rhetorical *technê*, Megalith engineers generate a heuristic that reflects the problem's rhetorical situation, conduct an investigation framed by this heuristic, determine a course of action, and present this course of action to decision-making audiences through rhetorical acts and artifacts. These acts and artifacts must instill confidence in the engineer's proposed ideas and help decision makers efficiently make decisions. While Megalith engineers are most likely unaware that their practices are rhetorical, they actively engage in mentoring others in these practices with the purpose of rhetorical persuasion.

This research also explored how A3 project planning reports are used for mentoring new Megalith engineers in developing rhetorical *technê*, essential for deliberative engineering problem solving. The Megalith A3 report acts as a culturally accepted technology that frames and influences the engineer's heuristic, or approach to investigation and inquiry, and enables the engineer to influence management to accept a proposed course of action. These A3 reports also

serve as artifacts for heuristic analysis, allowing mentors to guide novice engineers in learning the rhetorical, cultural and technology aspects of engineering problem solving.

Historical access to workplace culture, activities and practice is critical so that engineers can participate and contribute to the community. Megalith team leaders and group managers, support company values by mentoring new engineers in understanding Megalith workplace systems and helping them associate implicit heuristic questions with A3 field titles and generate new questions to suit situated assignments. These team leaders and group managers use A3 mentoring opportunities to model the collaborative interactions prized within the Megalith culture.

Mervin and other engineering managers who participated in this study also offered suggestions to university educators and undergraduates that could help undergraduates prepare for workplace practice. These suggestions serve to help undergraduates develop the ethos, pathos and logos necessary to be successful rhetorical and deliberative problem solvers. In Chapter 5, I present these suggestions from engineering managers and draw from my experiences with students, faculty and this research to address my final research question: How can educators help prepare undergraduates for workplace problem solving? I will pose pedagogical possibilities for educators who wish to guide their students in the development of deliberative problem-solving skills, which will be essential for future workplace success.

Chapter 5

Pedagogical Strategies for Helping Undergraduates Prepare for Workplace Problem Solving

Introduction

University educators may not consider the expectations of workplaces to be their primary concern in their instruction of undergraduates, but academic institutions have come to acknowledge the exigent goal of preparing undergraduates for workplace practice, which like academic practice supports the advancement of knowledge. In this chapter, I begin to pose suggestions to address my thesis question: how can universities, curriculum planners, and educators help undergraduates prepare for the problem-solving experiences they will encounter during their careers after graduation? I begin by presenting my findings from three engineering managers who identify strengths and difficulties that new engineers often have in the workplace. I then suggest pedagogical approaches that educators might employ to help undergraduates understand rhetoric, not only as a *technê*, or flexible technique for rhetorical problem solving, but also as *praxis*. To understand rhetoric as *praxis*, students develop the practical wisdom to situate themselves rhetorically within a professional community in order to consider multiple perspectives and contribute to productive decision making. I also suggest that educators across disciplines develop a coherent curricular plan as a community to mentor students as curricular apprentices through a variety of participatory and deliberative-problem learning experiences.

The Challenge

By the time they graduate, today's undergraduates will have accumulated a considerable amount of experience engaging in teamwork, completing tame and deliberative problem assignments, and developing foundational knowledge in school, personal, and/or work contexts. All three of the engineering managers that I interviewed for this research reflected extensively on their experiences hiring and working with new engineering graduates. These observations provide interesting insights into how university educators can help undergraduates prepare for workplace deliberative problem solving. Their observations suggest the exigency of guiding undergraduates in rhetorical *praxis*.

Strengths in Engineering Knowledge, Testing and Design

All three of the engineering managers have extensive experience hiring and working with new engineers. In particular, Greg and Mervin are responsible for hiring and managing new engineering graduates to support company initiatives. From these managers, I got a clear sense of both the strengths of Michigan Tech engineering graduates as well as suggestions for enhancing undergraduate programs. In my communications with Mervin, who interviews recent graduates from many academic institutions, he noted some key strengths of Michigan Tech graduates:

> "Michigan Tech grads have a solid fundamental understanding of engineering and can apply it. They have a practical technical base and can apply the knowledge they learned better than engineers I have met from (other universities). When I interview candidates, I like to ask questions about their senior projects. I like to ask detailed questions of why they did what they did. Michigan Tech grads seem to know more details about their projects, including how they set up project schedule and budget. They give rational answers about the projects requirements. They also have a deeper understanding of the project details and why the materials were selected, how the design parameters were decided, etc."

Mervin is impressed with Michigan Tech graduates because they bring excellent foundational engineering knowledge and engineering design experience to the workplace. The engineering knowledge of Michigan Tech graduates also impresses Greg from the Gamut Company, who goes so far as to suggest that Michigan Tech engineering graduates are versatile in their approaches to design. Also, Greg is impressed by the high standards and the challenges posed to students in the undergraduate engineering programs:

> "We hire MTU grads because we find them to be well rounded in terms of knowledge and experience. They tend to have an excellent work ethic, show curiosity, creativity and originality in thinking and design. We recognize that MTU presents an excellent challenge consistently throughout the students' academic career and that MTU has high standards for performance against these challenges. Additionally, we see MTU providing their students a perception and viewpoint unique to larger schools and in this bringing diversity of approach to their design assignments."

These positive impressions account for why these managers often hire Michigan Tech graduates to contribute within their organizations. Yet, the engineering managers interviewed suggest that engineering fundamentals and work ethic are not the only important traits for an engineer; understanding the rhetorical aspects of problem solving is critical for professional success at their companies.

Struggles in Conducting Situated Engineering Investigation

The managers I interviewed provided much evidence that new engineers, from Michigan Tech and other universities, often fail to see the rhetorical nature of their work and struggle with the investigative and discursive aspects of their engineering assignments. New undergraduates often engage in ineffectual tame-problem approaches or de-contextualized invention strategies in place of conducting a rhetorical investigation. These compromised investigation approaches often result in inadequate solutions and reduce their value in the workplace.

Instead of drawing from rhetorical *technê,* engineers are more likely to address problem assignments as tame problems. These new engineers envision engineering assignments as

knowledge-oriented, where investigative strategies are intentionally brief and rely on "powerful" information or testing technologies to provide answers. Greg explains that before tools are applied, engineers should be able to describe the problem and then "explain how they would investigate the issue, research the problem, measure, and then develop a solution." When the engineer is able to describe the problem and an investigative plan, the engineer appeals to ethos (credibility), logos (logic) and pathos (emotions) by demonstrating the engineer's situated understanding, engineering and investigative skills, investigative findings, and proposed solutions.

The inability to plan and implement a rhetorical investigation can also result in de-contextualized invention, which is problematic for designing products with complex, multi-function subsystems. Greg reflects that "(n)ew engineers often feel that to do a good job, they must come up with an entirely original idea." These engineers seem to seek the glory of invention, but their solutions are rarely practical to implement, and often time-consuming rework is necessary to find suitable alternatives. Greg explains how such invention-focused and random problem-solving practices conflict with workplace aims:

> "The advancement of engineering requires engineers to stand on the shoulders of others. While I caution engineers to always observe and never violate ethics in the workplace, patents and good basic design practice, they should look for the merit in (others') designs and feel good about a discovery that leads to even better designs."

Greg's comments suggest that innovation, not invention, is more desirable, as a "productive way to advance knowledge and designs in engineering." Greg suggests that "(e)ducators should discuss the limitations imposed by the 'not invented here syndrome' with their students." Explaining the limitations of invention will draw attention to the importance of studying rhetorical situation and conducting a rhetorical investigation as a means of finding solutions that will influence decision makers.

In addition, Greg's experience interacting with new engineers suggests that new engineers are not aware that rhetoric and understanding rhetorical situation are important in workplace problem solving for motivating and influencing audiences. Rhetorical situation is critical for productive problem solving because it involves understanding how the issue (or problem), audience, and constraints create exigency, which provides an opportunity for rhetorical acts and discourse (Bitzer, 1968). In a workplace context, understanding rhetorical situation would include having an awareness of workplace systems and constraints, determining actual problem definition, as well as identifying needs of stakeholders and decision-making audiences.

All three managers interviewed for this study are alarmed that new graduates often have difficulty realizing the importance of understanding different perspectives when working on engineering assignments, especially the perspectives of decision-making audiences. Greg explains, "Engineers must interact with others as a team. At (Gamut), chances are very good that an engineer at any level will interact directly with people from the technician level through vice president or higher and across all functions." The engineer must learn to understand the needs of different audience layers and the aspects of engineering design work that drive a particular audience's support and enthusiasm. Greg explains, "A direct manager may need to be persuaded on the technical merits of a point, whereas a vice present will need to be persuaded on the business and financial merits of a point." The engineer collaborates and influences multiple stakeholder audiences within the workplace community through many means of communication, including interpersonal exchanges, reports, and presentations.

Victor, from the Versatile Venture Company, reflects on his own career path and his experiences working with talented, experienced engineers in startup companies to suggest that the engineer's rigorous pursuit to understand the many aspects of rhetorical situation is critical for building expertise and being innovative. Victor feels that engineers must be incessantly curious and persistent in their resolve to build activity awareness and expertise not only for immediate job

responsibilities but also in workplaces processes, systems, and culture in order to situate problem, audience, and constraints:

> "Take every opportunity to learn everything you can because you never know what will be useful later. The more you know, the more opportunity you can seize. Study the organization hierarchy and build a body of knowledge and familiarity by seeking out people to help them. Ask them to explain how things work. Ask follow-up questions. If you want to advance, you have to be a leader. Be provocative, aggressive, and persistent, and do not forget to take some risks."

Victor's comments suggest the potential for kairotic moments in engineering. Those undergraduates who continually focus on developing a rhetorical *technê* for addressing deliberative problems will be more productive, innovative, and better prepared to seize kairotic opportunities throughout their careers. Victor advises that educators can play a critical role in helping undergraduates:

> "I have a lot of respect for good educators. Many people can teach a subject, but not everyone can bring out and reinforce the behaviors and way of thinking that position students to rise above their peers in a competitive environment."

Educators are in a unique position to help undergraduates understand how the initiative to investigate and the drive to understand rhetorical situation opens up the possibility for discovering kairotic moments, advancing knowledge and finding innovative designs. All three managers feel that to be valuable contributors to workplace decision making, university graduates need to become proficient at situating themselves within workplace communities to understand the rhetorical situation at hand.

Helping Undergraduates Prepare for Workplace *Praxis* through Overt, Experiential Learning and Curricular Apprenticeships

From this thesis research, I have come to understand that problems in the workplace and in academic disciplines are often rhetorical and that rhetorical *praxis* is developed through varied study, through experience addressing deliberative problems, and with the guidance of mentors

and peers. Educators, for example, spend years engaging in rhetorical *praxis* by seeking and interpreting practices and perspectives of disciplinary audiences, by planning and investigating deliberative problems, and by influencing and advancing disciplinary knowledge through juried publication. In addition, I have discovered that practitioners might be incognizant that their work is illustrative of rhetorical *praxis*, which involves activities that may seem intuitive and obvious to those who are experienced in addressing deliberative problems in professional settings.

Overt Pedagogies

I propose that educators make the importance of rhetorical *techné* obvious to learners by pursuing overt (open) pedagogical approaches. Gee (2000) believes in an overt pedagogical approach because "(t)here is ample evidence that people do not learn anything well unless they are both motivated to learn and believe that they will be able to use and function with what they are learning in some way that is in their interest" (p. 33). I suggest that educators focus on overt pedagogies that inform students' decisions about learning engagement and provide critical framing that makes explicit how deliberative problem experiences situate learning within systems and communities as preparation for workplace practice. Critical framing helps students understand where they stand in the system and how learning relates to other systems (Gee, 2000, p. 68). Educators become interpreters and mentors to help undergraduates prepare for future problem challenges by addressing deliberative problem challenges in the context of layered systems like curricular programs and communities of practice, such as classrooms, disciplines, and workplaces.

To pose problem solving and writing as *praxis*, I suggest that educators transition from knowledge-telling masters, a teaching style originally criticized harshly by Freire, to supporting, guiding and mentoring undergraduates in participative learning experiences. Erika Lindemann suggests that pedagogy is often "what-centered," where teachers focus on presenting a body of knowledge (as referenced in Breuch, 2003). A "what-centered" approach is used extensively in

education to provide students with foundational knowledge necessary for future problem solving and to help educators establish quantitative learning assessments. While foundational knowledge is valued by workplaces, which is evident in the quotes from engineering managers included earlier in this chapter.

Yet, when learning consists of predominantly "what-centered," knowledge-telling approaches, undergraduates envision expertise as extensive domain or disciplinary knowledge, provided by their educators and presented in textbooks. Undergraduates position knowledge as unchanging and universally true and do not see how their learning experiences, including deliberative problem assignments, are situated within the activities of communities to advance knowledge. Haraway (1988) raises similar concerns when she criticizes how knowledge claims, originally applicable to a particular problem or question, can grow to be overreaching claims that are situated everywhere equally (p. 584). Such views deny bias and leave little room for considering other possibilities as a means of reaching new understandings.

Instead of "what-centered" approaches, Breuch (2003) proposes that educators rethink pedagogies to be "how-centered" (p. 128). These "how-centered" approaches reveal the situated nature of learning by inviting multiple perspectives and considering different contexts to reach new understandings. Such approaches align with situated learning, where positions and locations are overtly acknowledged and quest for closure, finality and simplification become irrelevant (Haraway, 1988, p. 590). As a result, "how-centered" approaches build upon Freire's (1993) answer to the banking model of education by suggesting a move to overt (or open) communications and pedagogical strategies.

For "how-centered" approaches, students and educator would strive to be situated co-investigators, where the educator is mentor, not master. Mentoring "means spending time and energy on our interactions with students -- listening to them, discussing ideas with them, letting them make mistakes, and pointing them in the right direction" (Breuch, 2003, p. 143). The

educator-as-mentor becomes acquainted with the students, which means getting a sense of their perspectives, their experience, their professional and personal goals, and their expectations for the course. This type of mentoring requires educators to think of learning and teaching as essential activities for building rhetorical, deliberative problem solving expertise. The educator fosters an environment that invites the co-creation of learning with and between students. In such environments, educators may be willing to temporarily deviate from pedagogical plans to address emergent student needs through collaborative meaning making.

Discovering Rhetoric through Analysis

I suggest that educators guide undergraduates in a variety of deliberative problems using heuristics as a means to launch an efficient, thorough and productive inquiry and investigation. Heuristics provide a systematic way to apply knowledge and help "students become more resourceful and discover effective ways to work through performance-related impasses" (Selber, 2004, pp. 70 & 131). Heuristics also provide a way to plan a situated inquiry and investigation efficiently and confidently. Deliberative problem analysis will require varying emphasis but typically will be evaluative to reflect upon past problems as well as productive towards addressing a new problem. For example, evaluative analysis could be conducted to reflect upon a past problem, design, approach and/or artifact from a historical perspective. In contrast, new problem analysis could be conducted to draw from what is known as a means to advance knowledge, innovate, design and/or create in a new context.

To help students understand rhetoric’s role in workplace and disciplinary practice, I propose that educators guide undergraduates in evaluative contexts and new problem-posing contexts. Through guided analysis, undergraduates grow to understand how the problem solver and delivered artifacts work rhetorically to influence a decision-making audience.

Evaluative Analysis of Case Studies

Evaluative analysis is useful for helping students understand how deliberative problems are rhetorical and how rhetorical situation influences constraints, outcomes and artifacts. Case studies of historical or hypothetical deliberative problems are excellent ways to introduce systems thinking to undergraduates. While case studies are simulation models that will not represent all aspects of workplace systems, students engage with these simulation models, that offer problem-posing frames situated with collaborative environments with peers and educators as mentors.

These opportunities help undergraduates realize how real life problems are often deliberative and ill defined and how rhetoric provides a means for addressing them. Studying case studies and related artifacts, offers "general theories or patterns, relating concepts to previous knowledge, describing concrete or abstract models, and indicating examples of incorrect use" (Selber, 2004, p. 70). Such analysis helps students gain confidence through rhetorical *praxis*, developing a *technê* for examining rhetorical situation and investigating deliberative problems. Through guided analysis, educators help students understand how heuristics are used to consider critical perspectives and to develop situated plans that employ knowledge, processes, and technologies strategically to investigate and influence decision making.

Evaluative Analysis of Technologies

To become active members of disciplinary and workplace communities after graduation, college graduates will need to be able to think critically and rhetorically about technology use and available expert resources to make meanings, advance knowledge, and innovate. Today's classrooms are increasingly learning-focused, drawing from the blended use of many expert resources and employing powerful simulation technologies that mimic those used in workplace practice. Technologies are considered as mindware upgrades that extend the potential of thought and vision and have served as “non-biological props and aids” (Clark, 2003, p. 10). Today's simulation technologies greatly expand the range of possibilities for locating and manipulating

data and information, testing hypotheses to support investigation, and communicating with peers and experts.

Problem solvers must know how to account for the ways that simulation technologies expand and limit capabilities and access. Students may not fully realize the importance of, nor have strategies for, exploring the contents of the learning simulation's "black box" to uncover and critique its benefits or deficiencies (Turkle, 2009, pp. 17, 33). When students do not engage in simulation critique, students will see the data or results from simulation activity not as probable findings but as absolute fact. When introducing a simulation, educators should guide students in evaluative analysis to review goals for using the simulation in the learning event, frame this simulation within the problem-solving process, and discuss flaws of the simulation (Aldrich, 2009, p. 85). The educators' guidance is essential to students, allowing them to draw from multi-modal resources of expertise, simulations technologies, and data judiciously to build knowledge, solve problems, and revisit as needed to support learning.

Evaluative Analysis of Reports and other Artifacts as Technologies of Practice

While in their undergraduate courses and later in the workplace, undergraduates will need to engage in collaborative learning activities with experts and other learners to interpret information, understand processes, and develop investigative strategies. Haas contends that to become literate in the practices of a discourse community, the student must have meta-knowledge and a meta-understanding of the rhetorical nature of disciplinary texts, the historical context of disciplinary work, and the aims of the authors within a discourse community (200, p. 359). Educators can provide students with opportunities to examine and critique how communities rely on artifacts to prompt consideration of rhetorical situation and guide investigation.

The analyses of artifacts (such as reports and papers), situated within the domain of the course, help students understand how their learning will benefit them in the future. Reports and

forms act as "technologies of practice" because they drive learning communities to engage, build social structures, and advance work (Lave & Wenger, 1991, pp. 58 & 101). The side-by-side analysis of rhetorically effective (persuasive) reports or other artifacts provides an opportunity for deep understanding and reflection. Reflection is important so that "the rhetorical nature of the interaction" can be understood (Kolko, 1998, p. 66). Such analysis could help students understand both genre-specific discursive practices as well as the domain-specific use of knowledge and simulations for problem solving.

Educators should strongly consider including evaluative analysis as a pedagogical approach because it provides those students without experience in particular domains (such as scholars in other domains or undergraduates who are new to a domain) a way of understanding how knowledge is advanced through *technê* and *praxis*. Perhaps more important, however, is that rhetorical analysis is very useful when undergraduates encounter new deliberative problem challenges. The analysis of artifacts (including the peer review or analysis of work) provides opportunities that invite the learner to adopt a “productive reflective stance” when engaging in problem-posing experiences (Gee, 2007a, p. 137). The undergraduate's personal values and experience bring a unique perspective to the act of reflection, allowing the user, with the assistance of educators, to critique how the artifact (or report) facilitates or interferes with the completion of actions, goals and strategies that make success possible.

Problem Analysis in Problem-Posing Contexts

Workplace deliberative problems require people to interpret rhetorical situation, develop and adjust plans to investigate the problem, implement the investigative plan, and propose a course of action to influence others. To help undergraduates prepare for these activities, educators should construct pedagogical approaches that expose "students to theories of rhetorical invention, enculturation, and discursive practice," which will help them transition to the workplace, where they will "work as mediators within groups and across complex and often-

conflicting organizational alliances" (Brady, 2007, p. 41). Serious deliberative problem-posing games can help undergraduates contextualize their learning within curricular knowledge-building systems and workplace systems while at the same time stressing the importance of rhetorical principles, cultural practices and the technology critique necessary for critical problem solving.

Deliberative-problem game experiences offer opportunities to prepare undergraduates for solving future deliberative problems and offer experience in completing the cycle of learning (as seen in Figure 2.1). Students engage in critical thinking and reflection in the three stages of the cycle of learning to explore and understand rhetorical situation, to use and examine invention heuristic, and to engage in persuasive discourse while exploring a new domain or system. Problem-posing contexts invite students to role play within communities of practice, allowing them to gain experience building understanding and contextualizing this understanding as full practitioners with peers. In these experiences, students reflect on past and current practices but also establish their identity as active contributors to future practices (Lave & Wenger, 1996, p. 115 & 122). Students engage in these learning communities to engage, reflect, analyze, critique, and situate within the context of problem solving.

Selecting of Deliberative Problems, Processes and Models

The student develops an understanding of rhetorical situation that will drive investigation. Ideally, evaluative analysis and situated problem-posing contexts will pose deliberative problem challenges that reflect students' interests and goals. Workplace deliberative problem scenarios would be ideal. For such situated, deliberative problem-posing contexts, the educator first determines the domain, which is the setting or field of focus, to enable the exploration required to meet pedagogical objectives. For example, an engineering educator may select a bicycle manufacturer or popular magazine publisher as a domain.

When selecting artifacts, technologies, and case studies for evaluative analysis, educators should choose examples from communities of practice that interest students as a

means of inspiring participative meaning making. Ideally, students would have opportunity to conduct evaluative analysis of workplace documents and technologies situated within cultural systems. In addition, students can analyze academic papers as examples of how communities advance knowledge and how people build expertise by considering the rhetorical situation within the context of discipline and their research interests. Most importantly, however, the educator should guide students (as interpreter and intended decision-making audience) in the evaluative analysis of past examples of completed class assignments.

Ideally, educators will help students understand a problem-solving model or problem-solving frame that is appropriate for the particular problem-posing challenge. Selecting a problem-solving model can be a difficult challenge to educators because each discipline and workplace has its own standard(s) and these will evolve over time. Educators should help students begin learning how to use a model within the context of rhetorical situation so that in time students will gain experience in customizing models to suit the problem, workplace, and audience. In her research, Brady (2007) found that the graduate students, who lack workplace experience, tended to envision an invention model as a linear process, using them only as a checklist to record information, but as these students entered the workplace they relied on the models/problem-solving process as an "interpretive guide" to jump start inquiry in entirely different workplace contexts (p. 53, 55 & 56). I believe that, with experience addressing a variety of problems, students will become more confident and will continue building expertise in problem solving in school and later in the workplace.

As long as pedagogical approaches, theories, activities, and plans address the rhetorical aspects of deliberative problems, these models and a growing rhetorical *technê* become useful to undergraduates as possibilities to consider when students address future deliberative problem challenges. In the remainder of this chapter, I will focus on aspects of rhetorical *technê* that are often missing from disciplinary models and processes and seem to plague new graduates: using

a heuristic to design an investigation and developing a plan for rhetorical acts and artifacts. These rhetorical practices reveal how rhetoric enables problem solvers to influence decision-making audiences.

Using Investigative Heuristics to Guide Deliberative Problem Experiences

When educators present deliberative problem challenges, undergraduates will need to engage in problem-solving *praxis* through the application of rhetorical *technê*. Rhetorical *technê* is an adaptable productive knowledge for investigating, innovating, and persuading in the context of rhetorical situation, which the rhetor develops and evolves with experience. *Technê* includes methods for applying a heuristic to identify constraints (requirements and performance metrics), for investigating rhetorical situation, for gathering foundational knowledge, for gaining activity awareness, and for blending ideas to form new possibilities. In addition, rhetorical *technê* includes flexible strategies for appealing to pathos, logos and ethos through rhetorical acts and artifacts, which are intended to influence a decision-making audience.

Due to the importance of problem analysis to student understanding, the educator should consider scaffolding analysis activities carefully using heuristics to reflect the disciplinary knowledge and experience of the students. Heuristics are particularly useful for analysis, consisting of an assemblage of question prompts and topics that offer as a systematic way to conduct rhetorical analysis. Students must find an appropriate heuristic, but they will not be able to draw from sufficient investigative experience to construct a new, situated heuristic. Selber (2004) suggests that both disciplinary knowledge and expert guidance is essential for analysis (p. 131). I suggest that the educator begin by helping students form a heuristic that is suitable for their situated problem and guides them in building rhetorical *technê.*

Customizing a heuristic that was applied to a similar or more complex problem is an efficient way to assemble heuristic questions. Enos and Lauer (1992) suggest that there are two types of heuristics for addressing situated problems: recycled heuristics that have been used successfully for similar problems and generative heuristics that are customized to meet unique problem needs. A recycled heuristic "saves rhetors from reinventing the wheel of investigatory alternatives," offering a "strategic intuition" for more common types of deliberative problems (Brady, 2007, p. 59). A recycled heuristic represents historically successful question prompts reflective of all applicable domain communities. Yet, a rhetor should critique a recycled heuristic and then customize (or generate) new question prompts and topics to suit the specific deliberative problem.

Once the heuristic is formed, the educator assists students in using the heuristic as a means of broadening an investigation within the narrowed context of the problem's rhetorical situation. The critical study of the rhetorical situation, existing systems, and ways of addressing problems is considered to be a key requirement for creative problem solving and innovation. Greg stresses that new graduates understand workplace organizational structures:

> "I'd love to see engineers come into the workplace with a basic understanding of how corporations are constructed, what the basic functions do, what they need to do their basic jobs, and how to communicate with them. For instance, every large company I know of has management, engineering and technology, finance, marketing, and production/manufacturing. Each functional area will have a different set of expectations, which will most likely be similar to those expectations in other companies or industries. In fact, through my peers at other companies I've yet to see any real discernable differences."

For the undergraduate who is unfamiliar with expectations of communities and audience, understanding audience will be very difficult. Undergraduate will need the help of educators to understanding workplace environments and the needs decision-making audiences when given problem-posing challenges in workplace contexts. Educators should encourage students to seek

expertise outside the classroom by assisting them in locating people, textbooks, published articles, and presentations.

Using an Evaluative Heuristic

Evaluative analysis helps reveal the rhetorical practices inherent case studies and the ways in which technologies, rhetorical acts, and artifacts facilitate meaning making and influence audiences within cultural systems. An analysis in the context of culture would include the careful examination of rhetorical situation as well as the ways that related community practices influence design, technology use, and artifact development. When the undergraduates begin engaging in situated *praxis* on their own deliberative problem assignments, they will be able to draw clear parallels from the rhetorical analysis of completed case studies, technologies and artifacts.

When conducting a heuristic analysis of artifacts and other technologies, the student must see the cultural practices as both visible and invisible. When visible, the student can understand the artifact's function in a problem-solving system, and when invisible, the student can participate more directly in the situated use and critique of artifacts as technologies of practice (Lave & Wenger, 1996, pp. 101-103). Heuristic analysis of existing documents, technologies, and practices is challenging for students and requires the guidance and mentoring of educators.

The evaluative heuristic provides a tool for conducting a reverse engineering study of deliberative problems. While evaluative heuristic questions will be unique in the context of genre, domain, and specific problem, a recycled heuristic, such as the one I generated during my analyses of Megalith workplace reports (Table 5.1), can be a valuable resource:

Table 5.1
Example evaluative heuristic questions for analysis.

Special Topics	Heuristic Questions
Form and Function	What is the function of the artifact and why is it a rhetorical artifact? Is this a standard form? What other rhetorical acts are being used? How do rhetorical acts advance knowledge within this domain?
Problem	What was the original problem assignment? How has the writer interpreted the problem? What is the history surrounding this problem? Who has been negatively affected by this problem? Who will eventually benefit from a solution to this problem? What are the expected benefits of conducting this problem assignment (such as to company and society)?
Decision-Making Audience	What do I know about this domain and the situated culture? Who will receive this document? Who are the stakeholders? Decision makers? How are needs of decision makers and stakeholders reflected in artifact? How are expectations of communities of practice reflected in this artifact?
Constraints	What characteristics (qualitative special topics) are mentioned in the original assignment? In this document? Are they implied? Why? What requirements (quantitative common topics) are identified in the original assignment? In this document? Are they implied? Why? What activities and resources are identified in the original assignment? In this document? Are they implied? Why? What approaches are used to define requirements?
Appeals to Ethos, Pathos and Logos	What is the tone of the language and how is attitude expressed? How does the author create credibility? How does the writer appeal to the audience's emotions? How is the approach logical? What domain-specific terms or practices are evident in this artifact? What domain-specific investigative techniques are referenced?
Constraints	What constraints (requirements / performance metrics) are mentioned? What are the needs of problem's root sufferer or beneficiary? What topics are important to my decision maker? Stakeholders? What needs to be defined with a description or specifications? What comparisons should I make? Have I defined all constraints to be quantitative?

Source: Inspired by this thesis research and developed by Jean DeClerck.

The heuristic questions that I have identified in Table 5.1 could be recycled for new assignments to help undergraduates understand the rhetorical aspects of deliberative problems and learn more about the workplace or disciplinary cultures where deliberative problems take place. These questions are meant to prompt subsequent inquiry, which will generate additional heuristic questions that are specific to the problem's rhetorical situation.

Since developing the above table, I have discovered other investigative heuristics that would be useful for recycling. For example, Dr. Wendy Anderson provides her students with excellent heuristic question compilations for the rhetorical analysis of new media (Anderson, 2011; Anderson, 2012). These questions are intent on discovering how the rhetorical artifact is or is not influential in inspiring the intended action.

Investigative Heuristic for Addressing Deliberative Problem Assignment

Problem-posing deliberative experiences within the domain of a discipline, sub-discipline, workplace, or department may have a similar rhetorical situation, and recycled heuristics may provide students with a means to build up and customize the investigative plans that have taken place before. These questions are intended to help students plan, and students must take into consideration how their problem's rhetorical situation is unique by considering or creating other heuristic questions. In Table 5.2, I propose a compilation of heuristic questions, inspired by this thesis research, which can be recycled and customized to suit a new situation as a means to better understand the rhetorical situation surrounding a problem.

Table 5.2
Potential generative heuristic questions (part 1)
to understand rhetorical situation and identify special topics of inquiry.

Special Topics	Heuristic Questions
Problem	What was the original problem assignment? What do I know about this problem? Who has been negatively affected by this problem? Who will eventually benefit from a solution to this problem? Why is this a problem? What is the root problem? What is the history revolving around this problem? Do I have an appropriate heuristic (from similar or more complex problems) to recycle and adapt for this problem? What are the expected benefits of conducting this problem assignment (such as to company and society)?
Decision-Making Audience	What do I know about this domain and the situated culture? Who are the stakeholders? Who is the decision maker? How would the decision maker interpret this problem? What does the audience expect to do with this information? What artifacts and acts are expected and how are they being used to advance knowledge or make decisions within this domain? What are the audience's needs and expectations?
Constraints	What constraints (requirements or performance metrics) are mentioned in the problem assignment? What are the needs of problem's root sufferer or beneficiary? What are the stakeholder needs? What topics are important to my decision maker? What information does my decision maker need to make a decision? What needs to be defined with a description or specifications? What comparisons should I make? Do they require additional clarification? Have I defined all constraints to be quantitative?
Appeals to Ethos, Pathos and Logos	How can I convey my attitude to best influence decision makers? How can I create credibility? What would be a logical approach to investigation? What domain-specific terms or practices should I include? What domain-specific investigative techniques should I use?

Source: Inspired by this thesis research and developed by Jean DeClerck

After using heuristic questions to conduct an analysis of rhetorical situation (such as those presented in Table 5.2), students generate a list of themes that should be addressed through the course of the investigation. The students then explore this rhetorical situation with subsequent heuristic questions to reveal the characteristics, requirements, activities and resources needed to conduct a situated investigation. I created the following table to demonstrate how rhetorical situation is explored to plan a productive, situated investigation.

Table 5.3
Generative heuristic questions (part 2) to identify investigative plans.

Type	**In context of rhetorical situation:**
Characteristics of Interest (Special Topics)	What characteristics are important to address this topic?
Requirements (Common Topics)	What quantitative requirements can be assigned to these qualities?
Investigative Activities and Resources	What activities and resources are necessary to determine if requirements are met?
Rhetorical Acts	What rhetorical acts should be used to influence decision makers?

Source: Inspired by this thesis research and developed by Jean DeClerck

The undergraduates construct an investigative plan suitable for a decision-making audience and submit plans through rhetorical acts and artifacts, such as formal and informal writing, speaking, and acting, to peers and educator for review. Rhetorical acts and artifacts are an important aspect of *technê* because they provide rhetorics, which are the students in this situation, with opportunities "to recall and communicate procedural knowledge" and persuade others that their ideas "offer a legitimate contribution to existing knowledge" (Wickman, 2012, p.

8). When students weave their understanding of rhetorical situation and situated use of investigative strategies into rhetorical discourse, the decision-making audience will understand how plans were formed and findings were reached.

Guiding Undergraduates in Presenting Investigative Plans and Final Reports to Influence Decision Making

Undergraduates will probably have difficulty identifying all the rhetorical acts and artifacts that are useful for promoting an innovative idea, process or design as a course of action for a situated rhetorical, deliberative problem. I propose that the educator make problem-posing experiences more real by assigning or helping students plan rhetorical acts and artifacts. Ideally, students' project plan proposals and final reports would be delivered in ways that reflect professional practices of workplace, academia or other applicable communities.

For presenting project plans that draw from workplace practices, I suggest that A3-style reports be used since they are flexible and customizable to suit an educator's needs (as decision maker) as well as the situated problem assignment. The simple format of an A3 report template offers a useful means for students to sharing project plans with peers and educators. Peers and educators review the short A3 reports and provide suggestions and comments to enhance the investigative plan before it begins. Once approved, students implement project plans to investigate, explore possible solutions, and consolidate until they have "rhetorically sophisticated" final proposal to address the deliberative problem at hand (Bartholomae, 2003, p. 629). Students would then present their final proposed course of action via rhetorical artifacts. For final reporting assignments, educators could require A3 final reports, full technical papers, short presentations, websites, abstracts, video, posters and/or other artifacts that reflect professional practices.

Regardless of the type of act or artifact, I suggest that educators guide students in the use of templates, formats and rubrics to help them communicate rhetorically. Standard, but

customizable, forms and formats for assignments are useful because they provide a starting point for students to practice rhetorical delivery in the context of a social environment or discourse community (Winsor, 1998, p. 8). When given an artifact template, students are more apt to work together to practice crafting their rhetorical message.

Rhetorical artifacts do not speak for themselves. Since students are often inexperienced in rhetorical problem solving and anticipating audience needs, educators should be explicit about how their expectations can be met through the design of rhetorical acts and artifacts. The educator should demonstrate how to use rubrics and interpret case study examples to explain expectations. The expectations would include use of specific terminology, description of the rhetorical situation and investigation, interpretation of findings, and proposal for a course of action.

The undergraduates' ability to appeal to pathos, logos, and ethos through rhetorical acts and artifacts will directly impact their success influencing the decision-making audience. Greg suggests that it is important to consider, "What perception do I need my audience to have of what I've done or about me?" Educators as mentors and guides are in a unique position to help undergraduates examine their own attitudes and actions in the context of personal and career goals. While we "cannot be certain if students are successful in communicative interaction, ... we can encourage student to become more aware of their interactions with others" (Breuch, 2003, p. 135). Educators should remind undergraduates to be conscious of how their actions, whether intentional or not, might influence decision-making audiences both positively and negatively. In addition, undergraduates should be encouraged to follow Greg's advice to "take into account the productivity of others and the needs of their audience by being concise, accurate and complete in their communications (presentations, documents and discussions) with others." Due to critical importance of using visual elements, text, and data strategically to convey key information and influence decision-making audiences, undergraduates should be encouraged to develop

extensive skills in digital image manipulation and presentation. Foremost, educators should encourage undergraduates to build, evolve, and customize their strategies for presenting information, ideas, and claims most effectively to their audience.

Engaging in Rhetorical *Praxis* as Curricular Apprentices

My interviews with engineering managers and the analyses of A3 project planning reports provides compelling evidence that understanding a workplace community's practices is a critical aspect of deliberative problem solving and professional success. These managers felt that to be valuable contributors to workplace decision making, university graduates need to become proficient at situating themselves within workplace communities to understand the rhetorical situation at hand. In addition, engaging in rhetorical *praxis* reveals the community's "social dynamic that has practical power for solving shared problems" (T. Miller, 1991, p. 70). When engaged in rhetorical *praxis*, students situate themselves within a community to study how a community works; they begin to see how social practices and language flex to enable productive collaboration and problem solving.

Most undergraduates believe that expertise is achievable through the mastery of knowledge, rather than through the varied *praxis* of rhetorical problem solving, an impression that reflects their experience as learners within education systems. Yet, expertise is a process where people develop "the ability to work in (non-routine) ways on ever more demanding problems in whatever domain they are confronted with" (Gee, 2001, p. 48). Mastery and expertise become an infinite quest, and experts become those who have extended knowledge, ideas, and designs through rhetorical *praxis* in the context of cross-domain deliberative problem challenges.

Ideally, educators would provide their students with inclusive deliberative problem-posing challenges with a game-frame that allow undergraduates to conduct a full rhetorical investigation and implement solutions within established systems. Yet, educators may find it difficult to provide

undergraduates with adequate access to resources to investigate all aspects of rhetorical situation, such as multiple stakeholder perspectives of implementation systems, decision-makers within organizations, and consumer or societal end users. Instead, I suggest that educators and curriculum planners consider approaches used for apprenticeships when guiding undergraduates in developing a *technê* and understanding *praxis*. I believe the first step is to recognize undergraduates as curricular apprentices. In this scenario, the university is the undergraduate workplace community, undergraduates are decision makers of their education success, and educators are their mentors within the curricula. I consider curricular apprenticeship to be an organized system of learning opportunities, where educators mentor by drawing from their expertise in building disciplinary knowledge and in rhetorical *praxis* to inform, influence, and guide undergraduates.

An apprenticeship model, similar to those posed by Lave and Wenger, would not necessitate individual student guidance, but would require curriculum planners and educators to reconsider how undergraduates learn *technê*. Apprenticeship learning is not process driven but is a series "production activity-segments (that) must be learned in different sequences than those in which production process commonly unfolds" (Lave & Wenger, 1996, p. 96). While undergraduate curricula already have such activity-segments, in the form of testing or tame problem-solving procedures for example, undergraduates are not often aware of their situated use for addressing rhetorical problems. In an apprenticeship model "(t)hings learned, and various and changing viewpoints, can be arranged and interrelated in ways that gradually transform that skeletal understanding" (Lave & Wenger, 1996, p. 96). This model suggests that educators be overt in explaining the interrelationships between activity-segments and the critical framing of different activity-segments within a rhetorical *technê* for deliberative problem solving. Further, universities and curriculum planners would help educators understand how curriculum and other university initiatives support the undergraduates' preparation for workplace practice.

For a curricular apprenticeship model, curriculum planners and educators would plan activity-segments instead of the predominately knowledge-focused modules that comprise most undergraduate curricula. Knowledge-focused curricula may prevent undergraduates from realizing the rhetorical action and expertise building that takes place around them. For example, in one published research study, a biology student envisioned texts, discourses, educational activities and apprenticeship experiences as autonomous events throughout most of her undergraduate experience, and only in her final year came to realize the dynamic rhetorical action that was taking place around her (Haas, 2001, p. 358). While Haas intended to illustrate how undergraduate curricula deliberately scaffolds knowledge and understanding to guide students, I was quite alarmed that the student held a modularized and arhetorical view of her learning experiences until late in her university experience.

Some aspects of workplace apprenticeship model are evident in existing undergraduate curricula. For example, undergraduate curricula typically have a focus, clearly defined beginning and ending points and collaborative learning experiences (or courses). Curricular apprenticeships consist of a variety of multi-disciplinary learning opportunities (much like apprenticeships and new employee training in other workplace contexts). So my suggestions are relevant to instruction in any discipline, including business, science, engineering, humanities, social sciences, math, etc.

As part of a curricular apprenticeship, educators would foster collaborative and innovative affinity groups of highly motivated collaborators intent on advancing knowledge and designs. Students would be encouraged to formally and informally seek each other to build understanding as important preparation for future problem solving. Trust and respect are important aspects of learning communities that students will encounter in workplace, civic, and education. Mary Louise Pratt (1999) suggests the need for “safe” learning spaces that build trust so that perspectives will be shared and respected. The educator must take care in establishing learning communities where students work together to solve problems and are encouraged to acknowledge the

perspectives of peers. Educators must be "deliberately reciprocal" in their interactions with learners and promote "codes of behavior" for acknowledging other perspectives (Royster, 2003, p. 615). When the emphasis of learning environments is on respect, all students become cognizant of how their ideologies, values, histories, and perspectives play a part in the learning event.

Learning communities that encourage multiple perspectives provide opportunities for advancing knowledge. James Gee (2000) hints at this potential when he suggests that "it is not really important what individuals know on their own, but rather what they can do with others collaboratively to effectively add 'value" to an enterprise" (p. 49). Undergraduates can use learning communities to better understand foundational knowledge and practice, but they can also engage in delivering and interpreting rhetorical discourse and realize the benefits of alternative audience perspectives for constructing innovative and productive ideas.

I propose that educators offer guidance through their delivery of information, in their construction of challenges and assignments, and in their engagement with learners. The students' motivation and dedication to the learning activity will be closely tied to their identities in the learning community in a physical classroom and in virtual communication spaces. For this reason, educators carefully consider how communication technologies and activities might help or hinder the formation of affinity groups in classroom and virtual spaces used by learners. Communication technologies must support "the sort of lightweight, unplanned interactions we witness each day in the places we work" (Johnson-Eilola, 2005, p. 96). Some technologies and activities will be better than others for these interactions. Online technologies and techniques would be evaluated through heuristic analysis. Ideally, an educator would design, support and guide students in a problem-posing, blended learning experience, using a variety of pedagogical approaches and technologies, such as classroom discussion, a learning management system,

and possibly a technology that supports special collaborative work, such as a Massively Multiplayer Online Role Play Game (MMORPG) technology.

With a curricular apprentice model, curricula would include many sorts of activity-segments, including domain knowledge and process activities, but also activities that support the undergraduate in conducting different aspects of a rhetorical investigation. Ordering of these activity segments would certainly work towards building knowledge and emphasizing topical importance. Yet, ultimately curricula would support the scaffolded building of flexible rhetorical expertise (considering rhetorical situation, planning, and conducting investigation and delivery of influential information) throughout the undergraduate's college experience, while encouraging undergraduates to make connections between experiences in different domain and disciplinary contexts. Educators and curricular planners would coordinate their efforts by developing a vocabulary for rhetorical practice, sharing how knowledge advances in workplace and disciplinary contexts, and developing pedagogical approaches for helping undergraduates develop rhetorical *technê* for addressing future deliberative problem-solving challenges.

Conclusion

New graduates will encounter deliberative problems regardless of their career path after graduation. This chapter has suggested possible pedagogical approaches for engaging students in the *praxis* of rhetorical problem solving that will allow them to systematically address deliberative problems. To help students understand how rhetoric plays a part in workplace problem solving, I propose that educators guide undergraduates in the rhetorical analysis of case, studies, technologies, and artifacts from workplaces and academia. To help students form a rhetorical *technê* for deliberative problem solving, I recommend that educators pose deliberative problem challenges to guide undergraduates in using a heuristic to frame an investigation and to help undergraduates plan rhetorical acts. Finally, to prepare students to be innovators and

influential in workplace decision making, I suggest that educators design activities, foster learning communities of practice, and offer mentoring to support students as curricular apprentices.

The pedagogies in this chapter are intended to provide students with tools to draw from when encountering deliberative problems in the future. By drawing from a *technê* for rhetorical problem solving, these undergraduates would be able to customize and conduct an investigation, to innovatively design and advance knowledge, and to produce influential acts and artifacts to convey their ideas to a decision-making audience. As they proceed in their undergraduate programs and enter the workforce, they would be able to construct and apply heuristics to investigate new problems, allowing them to adjust to new situations and to engage productively with others.

The educator, as mentor and guide, would play a critical role as interpreter to help undergraduates understand how to conduct rhetorical analysis and engage in rhetorical *technê* and *praxis* in the context of situated deliberative problems. The educator would guide undergraduates in the blended use of expert resources, simulations, and data. The educator would also offer different perspectives for students to consider in their learning. In learning-focused instruction, the educator would build learning communities, where students sort through perspectives together with the educator. Such communities would invite students to share their own ideas and to reflect on the perspectives held by experts as a way to build (not replace) understanding and contextualize what they explore in their undergraduate classes. Expert and student perspectives would be collaboratively arranged and interrelated to form new understandings (Lave and Wenger 96). Such understandings would enrich and strengthen ideas, making innovation in both knowledge making and problem solving possible.

To build expertise for helping undergraduates, educators would form alliances between departments and would seek collaborations with industry. In the next and final chapter, I will continue to explore my second thesis question: How might universities support the

implementation of deliberative problems, situated learning approaches, and engaging learning communities to help students prepare for workplace problem solving? I will focus on how university systems can support the efforts of educators and undergraduates, and I will pose next steps for this thesis research.

Chapter 6

Conclusions

To support educators who wish to help undergraduates prepare for future problem-solving challenges, I have suggested possible pedagogical solutions by drawing from my workplace study, including document analyses and interviews with engineering managers, which revealed the important role of rhetorical *technê* in problem solving and decision making. I have discovered that with guidance and opportunity workplace problem solvers develop *technê* that offers a flexible and adaptable means of anticipating kairotic moments, of conducting a situated investigation that reflects the interests of disparate perspectives and of influencing others to implement, act or consider other productive possibilities. I have come to understand how developing *technê* and engaging in the *praxis* of rhetorical problem solving empowers engineers to seek understanding, innovate and contribute to the advancement of knowledge. Stemming from these research discoveries, I have suggested that educators overtly mentor and engage undergraduates in collaborative case study and document analysis opportunities and problem-posing experiences, where students are encouraged to reflect, investigate, innovate and strategically construct discourse to inform and influence decision making.

Educators are uniquely situated to help undergraduates become proficient in interpreting the rhetorical situation surrounding real problems so that they can realize *kairos*, investigate and find productive and innovative solutions. In this chapter I offer my final insights about deliberative problem solving and suggest avenues for educators to explore in order to inspire and guide undergraduates. First, I provide a final analysis by sharing some key ways in which my workplace study with engineering managers has extended my understanding of rhetorical theory. Second, I

apply rhetorical *technê* to frame next steps for educators who wish to inspire and prepare undergraduates to be rhetors who actively contribute to disciplinary advancement and innovative design. Finally, I draw upon my analysis to reveal some unforeseen pedagogical implications of developing deliberative (rhetorical) problem-solving *praxis* and to suggest new challenges to address in the future.

Final Analysis

Types of Workplace Problems

My interviews with engineering managers helped me to better differentiate between deliberative problems and tame problems and suggest that engineering assignments may be posed as tame or deliberative. Tame problems have an expected outcome (with a right and wrong answer), often requiring the problem solver to follow a process to identify the outcome. Tame problems do not invite the problem solver to consider the situated consequences, to deliberate next steps, or to offer opinions for future action; instead, other people accept the responsibility of considering tame solutions and making decisions to suit the situation. For example, engineers may receive tame problem assignments to perform particular test or retrieve technical knowledge to perform a narrowly defined task for decision makers, who will determine the best course of action.

In contrast, deliberative problems have no particular anticipated outcome, which necessitates rhetorical investigation to help problem solvers find, deliberate and present recommendations to decision makers. Engineers may receive many different types of deliberative problems assignments. Examples would include designing components or entire products, evaluating competing products or components, troubleshooting product consistency issues, or establishing a specification for a product line. For a deliberative problem, the engineer applies both technical knowledge and rhetorical *technê* to plan and implement a situated (efficient)

investigation and offer a proposed course of action to a decision-making audience (often a manager). The manager considers the engineer's proposed course of action within the manager's own interpretation of rhetorical situation to make decisions.

My research revealed that problem solvers look for kairos in problems and can choose to address a problem as rhetorical and deliberative even if a problem is assigned as tame. Greg and Victor encourage engineers to address all assignments, even tame problems, as deliberative and rhetorical. When engineers choose to frame assignments as deliberative they find opportunities to develop a rhetorical *technê* in the context of workplace systems and culture. Rhetorical *technê* and *praxis* provide engineers with opportunities to take an active role in workplace decision making as well as disciplinary and workplace innovation and knowledge advancement. As a result, engineers' emerging expertise in rhetorical problem solving is beneficial in the short term, through the engineer's contributions to workplace decision making, and in the long term, through advancements in innovative design and disciplinary knowledge.

Using Rhetoric to Meet Short Term Goal: Guiding and Influencing Workplace Decision Making

The interviews with managers from both Megalith and Gamut suggest that engineers engage in rhetorical activities to meet short-term goals to influence decision making when they work as engineers-as-rhetors on deliberative engineering assignments. The engineer becomes a rhetor in three respects: by interpreting the problem within the context of rhetorical situation, by planning and conducting a situated investigation, and by proposing the rhetor's proposed course of action through rhetorical acts to influence a decision-making audience. Although engineers might not refer to their activities as "applying rhetorical *technê*," "understanding rhetorical situation," and "conducting heuristic analysis," these rhetorical practices are a critical part of engineering work. Rhetorical *technê* provides a systematic approach for contextualizing, generating and advancing knowledge and design to address uniquely situated problems. This

approach can be described in three groups of activities, although these activities must be repeated regularly to account for changes that will occur over time.

First, the engineer identifies project goals and requirements. The engineer investigates the rhetorical situation (problem, constraints, audience) using a heuristic. The importance of rhetorical situation was clear with all the engineering managers interviewed for this research. Greg from Gamut Engineering expressed the importance of understanding the rhetorical situation when he emphasized the importance of determining the "customer's actual need." Customers would include all end users, who benefit from engineering solutions, as well as society where engineering products will be used. In addition, both Gamut and Megalith engineers work to address the needs of other decision-making audiences, which includes horizontally situated system stakeholders across departments, such as from marketing and manufacturing departments, and vertically situated stakeholders, such as management, within organizational structures. Engineers must proactively seek activity awareness, which will include an understanding of organizational structures, workplace culture and practices as well as available human and information resources of expertise.

Engineers rely on recycled heuristics, which are collections of investigative topics and questions that were used for previous (similar) deliberative problem assignments, to begin the inquiry necessary to thoroughly understand rhetorical situation. Engineers apply heuristic questions to identify special topics of interest to the decision-making manager, which include topics related to a particular problem assignment, workplace systems and stakeholders, workplace cultures and disciplines. Engineers apply subsequent heuristic questions to identify applicable categories and investigative goals and requirements, which may be qualitative or quantitative. The engineer will then work to translate qualitative requirements, which may be end-user or customer requirements, into a comprehensive list of quantitative engineering requirements.

Second, engineers use project goals and requirements as objectives and constraints to develop a proposed project plan to investigate their project assignment. Engineers follow their company's reporting practices to submit project proposal plans for approval. Many companies, such as Megalith, use A3 report templates for this purpose. Once these project plans are approved, engineers conduct their investigation to pursue different possibilities and then evaluate options using optimization techniques to form recommendations.

Finally, engineers share recommendations and investigative approaches with project stakeholders and decision makers in ways that will appeal to ethos (credibility), pathos (emotions) and logos (logic). If successfully conveyed, decision makers will take the engineer's recommendations into consideration when making decisions for the company. In this way, both rhetor and audience engage in deliberation to determine the best course of action. The rhetor proposes an opinion, and the manager decides whether to accept, alter or reject this course of action.

Using Rhetoric to Meet Long Term Goals: Innovating and Advancing Knowledge

The relationship between rhetorical investigation and innovation was an unexpected connection that emerged from my workplace research, suggesting the importance of rhetoric in meeting long-term goals in workplaces and disciplines for innovating and advancing knowledge. This exploration began when Greg, one of the engineering managers interviewed for my workplace study, implied the negative consequences of invention, which he suggested was an arbitrary creative practice that was an unlikely precursor to productive and efficient engineering advancement. Instead, Greg suggested that the rhetorical practices that take place during a situated investigation are critical for advancing knowledge and designs. According to both Greg and Mervin, thoroughly understanding rhetorical situation is critical and would includes understanding the underlying problem, understanding the needs and expectations of decision-making audience, and understanding the constraints of problems and implementation systems.

An investigative framing, reflecting a thorough understanding of rhetorical situation, can lead to an innovative solution that extends design and knowledge and/or a productive course of action that is useful in a situated context to produce objects, processes and so on. Perhaps more importantly, understanding rhetorical situation can reveal kairotic opportunities.

As a part of *technê*, the engineer-as-rhetor defines a situated investigation and implements rhetorical acts, such developing an A3 project plan report, to influence decision makers. The use of rhetorical *technê* is not restricted to "conveying neutral, sterilized facts," but instead is intended to inspire change, such as "to carry away the audience; to produce an effect on them; to mold them; to leave them different as a result of its impact" (Barilli, 1989). Rhetorical *technê* inspires change in perspective and understanding that may influence decision making and action. Wickman (2012) suggests that *technê* is "less a mode of revealing or discovery" than it is a process for extending accepted knowledge through "productive technical intervention" to generate new meanings (p. 38). Addressing problems as tame, where thinking is restricted to recalling knowledge or following an accepted process, does not provide opportunity for the problem solver to extend understanding by offering a suggestion, opinion, supposition or interpretation.

In the case of deliberative problems, rhetorical *technê* enables us to extend knowledge and design through a systematic investigation to locate relevant established knowledge or designs and to suggest advancements to disciplinary knowledge or workplace object or process design. With Mervin's interpretive assistance, I came to realize that the A3 report does not enforce a process. The template's fields set Megalith's expectation that the engineer conduct a rhetorical investigation. In addition, the form provides a familiar receptacle for sharing ideas, information and, eventually, the engineer's proposed course of action to inform and influence decision making.

My research with engineering managers has shown that the roles of variable and invariable knowledge for innovation, which are a part of scientific advancement, are also present in engineering deliberative problem solving. Engineers begin with knowledge that is accepted by disciplines and workplace as invariable, such as data gathered through accepted practices. Engineers then contribute variable knowledge, including aspects of problem's rhetorical situation, the engineer's interpretation, and the historical strategies used for similar problems (including heuristics, findings and rhetorical acts). This bridge leads engineers to extend existing knowledge, practice and designs to find new innovative possibilities.

The interviews I conducted with engineering managers revealed the beneficial correlation between building problem-solving expertise, innovating, and advancing disciplinary knowledge. As Victor noted, "the ideal engineer will receive a basic assignment with fixed milestone dates and be able to think critically and creatively to identify innovative solutions and to communicate them effectively." The engineer who engages in an efficient situated, rhetorical investigation to identify and propose solutions is particularly valuable to workplace decision makers. This research also revealed how heuristics, as an aspect of rhetorical *techné*, play a critical and empowering role by helping the problem solver determine topics for a broad, situated investigation opening opportunities to advance knowledge and design. All three engineering managers stressed the importance of seeking out the knowledge and expertise of fellow engineers, investigating the engineering designs used within related industries, and seeking assistance to understand workplace systems as a means to advance knowledge, to design innovatively, and to be prepared for compelling opportunities that may arise in the future.

Realizing the Exigency of Building Rhetorical Expertise

My research with engineering managers has confirmed the exigency for being able to build rhetorical expertise and engage in rhetorical *praxis*. Yet, undergraduates' failure to realize the exigency of this problem threatens their future as well as the university's reputation and the

morale of educators who are dedicated to teaching and helping undergraduates prepare for the future. Undergraduates, educators, and universities must realize the exigency of pedagogical practices that reinforce and guide undergraduates in rhetorical practice and building rhetorical expertise.

Undergraduates beginning their university studies typically will be unaware of the empowering role of rhetoric in the activities that surround them. While undergraduates will have had exposure to many technologies and learning experiences that could support rhetorical and deliberative problems solving, in the absence of rhetorical *technê* and investigative heuristics, they may fail to consider situated end-use, product design, and implementation systems. Undergraduates may mistake technological innovations as creative inventions. They may critique technologies and services only in the context of self-centered immediacy. They may misinterpret rhetorical acts as attempts to manipulate consumption and decisions. As a result, their own efforts to engage in rhetorical practice may manifest as callous and arbitrary expressions and creative invention, unpredictable in their ability to inspire productive action.

Undergraduates may prefer easily measured tame problems because they have experienced overwhelming success addressing tame problem assignments and unpredictable results addressing rhetorical problem assignments in school. While the managers recommend that engineers consider both tame or deliberative problems as deliberative, undergraduates are more likely to address both tame or deliberative problems as tame problems. Undergraduates will be uncomfortable sharing their perspective or proposing a course of action. Instead, undergraduates will tend to report findings as neutral and arhetorical.

Our undergraduates' ability to identify empowering kairotic opportunities, to innovate, to build expertise, and to influence decision making will depend on their ability to apply rhetorical *technê* as a means of building expertise for addressing deliberative problems. Undergraduates may fail to understand how deliberative/rhetorical problem activities in unrelated courses will build

expertise that is effectual preparation for workplace practice. Yet, undergraduates can build expertise that is transferrable between problems and domains through recycled heuristics and rhetorical *technê*. For this reason, while the focus of this research has examined the workplace learning and problem-solving practices of engineers, I believe that my pedagogical suggestions can be adapted to provide appropriate preparation for undergraduates in any discipline.

Existing Practices for Learning Rhetorical *Technê*

My workplace study revealed some interesting approaches for learning rhetorical practice, several of which informed my pedagogical recommendations to educators. Through interpretive interviews with Mervin, I discovered how Megalith engineers engage in the *praxis* of problem solving and build *technê* through collaborative-learning workplace environments and mentoring-style apprenticeships.

The interpretation of the Megalith A3 project planning reports, which included the Mervin's feedback to engineers, was a unique opportunity to examine the use of rhetorical *technê* in workplace practice. In the Megalith culture, engineers and managers guide new engineers' enculturation into workplace practices through the use of question prompts, which act as heuristic questions to support investigation. By interpreting each engineer's A3 report as well as Mervin's written feedback, Mervin explained how the fields of the A3 encourage the engineer to consider important heuristic questions, which will include "Who are the audiences and decision makers? What are their needs and expectations? How will this project help Megalith? What alternatives have been considered?" The engineer draws upon rhetorical *technê* to understand rhetorical situation and then identify special topics of interest, categories of interest, and finally goals and requirements. To find possibilities that address these goals and requirements, the engineer plans an investigation, consults with Megalith peers and specialists, and constructs an A3 report to propose this investigative plan to team leaders, group managers, and managers.

Pedagogical Suggestions

In Chapter 5, I proposed my pedagogical recommendations to educators to help undergraduates prepare for the *praxis* of deliberative problem solving. I begin by clarifying that the engineering managers interviewed for this study felt that while new Michigan Tech engineering graduates do have the engineering fundamentals and work ethic that are essential for engineering work, new undergraduates from Michigan Tech or other universities often lack a rhetorical *technê* and struggle to integrate rhetorical practices with growing situated engineering knowledge to address workplace deliberative problem challenges. I present perspectives of engineering managers that stress the importance of persistent investigation as a means for engineers to become expert, versatile and, therefore, successful engineers, who are prepared to build and advance knowledge and design innovative solutions.

To prepare students for the *praxis* of deliberative problem solving, I propose that educators focus on designing activities and developing an overt learning culture that fosters the creation of collaborative affinity groups. I propose that educators and curriculum planners envision undergraduate curricula as curricular apprenticeships, and I suggest that educators draw parallels between the engineer-manager workplace relationships and the educator-undergraduate university relationships.

In this context, the university is the undergraduates' workplace, where educators are rhetors and undergraduates manage activities so that they can achieve long-term goals, which often include careers in academia or different workplace domains. In the context of their courses, undergraduates are decision-making audiences, who will decide whether to engage fully in learning experiences that educators offer them. This interpretation suggests a departure from the educator's role as knowledge-teller and controller of knowledge to an informative rhetor who mentors and coaches students, who seek to advance knowledge. At other times, educators are decision makers who assess student work.

Educators would foster the development of affinity groups to support undergraduates as they discover the exigency of developing rhetorical technê, interpreting invariable knowledge and variable aspects of rhetorical situation, and building a *technê* for deliberative problem solving through engaging activities. These activities would include the use of heuristics to support both the rhetorical analysis of artifacts and deliberative problem-posing challenges that emphasize a game frame. To help students understand how rhetoric plays a part in workplace problem solving, I propose that educators guide undergraduates in the rhetorical analysis of artifacts from workplaces and academia.

Finally, to help students form a *technê* for deliberative problem solving, I recommend that educators pose deliberative problem challenges to guide undergraduates in using a heuristic. I also suggest that educators consider adapting the A3 as a heuristic to guide students in understanding the rhetorical situation, as explored by Bitzer (1968), when examining rhetorical artifacts, analyzing case studies, and engaging in deliberative problems assignments. Undergraduates will likely recall these experiences when the exigency of heuristics and rhetoric is made explicit. When these undergraduates encounter deliberative, rhetorical problems in the future, ideally they will recycle heuristics, used in previous analysis or problem solving, to launch an efficient, thorough, and productive inquiry.

Next Steps for Educators

I suggest that university educators and curriculum planners consider implementing these pedagogical approaches to inspire and guide undergraduates in the *technê* and *praxis* of rhetorical problem solving as preparation for workplace practice. To address the deliberative problem of helping undergraduates prepare for workplace practice, I suggest that educators draw parallels between the engineer-manager workplace relationships and the educator-undergraduate university relationships. In this context, the university is the undergraduates' workplace, where

educators are rhetors and undergraduates manage activities so that they can achieve long-term goals, which often include careers in academia or different workplace domains. In the context of their courses, undergraduates are decision-making audiences, who decide whether to engage fully in learning experiences that educators offer them. This interpretation suggests a departure from the educator's role as knowledge-teller and controller of knowledge to an informative rhetor who mentors and coaches students, who seek to advance knowledge.

In order to act in response to this exigent problem, educators must have a clear understanding of the rhetorical situation surrounding this exigent problem. For example, educators must understand the problem, which means that they must have an understanding of applied rhetoric, their decision-making audience (undergraduates) as well as deliberative problem solving in workplace contexts. Educators must understand the constraints imposed by university systems, delivery options, and course learning goals. Educators can investigate systematically by applying the following heuristic questions.

How Are Deliberative Problems Solved in the Workplace?

Educators, curriculum planners, and universities should make plans to help undergraduate students position themselves in the driving seat of forming rhetorical *techné*. Educators will need to begin by learning about applied rhetoric. This understanding will enable them to guide their students in understanding the rhetorical aspects of deliberative problem solving.

Since the post-process approach places less focus on what problem solving model or approach is taught, educators turn their instructional focus to teaching situated *praxis*. An educator with contextual expertise, is particularly valuable, mentoring students in using a heuristic to guide rhetorical analysis and offer background information and insights concerning the situated problem, such as culture, history, and needs of decision-making audience. In addition, the educator adopts the role of guide and coach to help undergraduates navigate university systems

and learn about workplace systems to solve deliberative problems. To be effective as a guide and coach, the educator appeals to ethos, pathos, and logos. In other words, the instructor must be a credible, concerned about students' future success, and familiar with workplace and curricular systems.

To help undergraduates understand and develop rhetorical *technê*, educators as mentors can provide their students with interpretive assistance and guidance when performing heuristic analysis of artifacts or rhetorical analysis of deliberative problem-posing game challenges. Thomas Miller (1991) suggests that if educators teach writing as *praxis,* "(w)e can foster such 'practical wisdom' by developing a pedagogy that contributes to our students' ability to locate themselves and their professional communities in the larger public context" (p. 68). Since interpreting is such a big part of deliberative problem solving *technê*, educators, regardless of their discipline, can play an important role as interpreter to help undergraduates develop *praxis* for problem solving.

Educators should seek opportunities to understand workplace *praxis*. Industrial advisory boards are commonplace at university institutions, and representatives from industry often visit universities to meet with educators and administrators. Often, these guests are invited to talk to students about workplace practice and to evaluate curricular systems. I recommend that educators revisit the rhetorical situation at hand by identifying heuristic questions that will enable them to better understand workplace *praxis*. Educators can begin by recycling heuristic questions, such as those I use for my workplace study. These included: "How do engineers use rhetorical practices, culture awareness, and technologies to support their engineering assignments? What rhetorical practices in engineering problem solving are particularly challenging for new engineers? How do engineers learn rhetorical practices in the workplace?" These questions would then be customized to the particular interests of the educator. Additional questions might include the following: "What optimization techniques are used for selecting

designs? How are specifications established across product lines? What types of reports are used? Who are the decision makers? What are some cases that I can use during instruction to explain engineering design? What design processes are used?" In particular, educators should consider how techniques, employed in industry, could be used to inspire student engagement in learning, whether or not deliberative problem challenges are used in instruction. Regardless of their plans after graduation, new graduates will likely engage extensively in manipulating digital media and will benefit greatly from instruction and opportunities to critique, design, select and use digital media.

What are the Needs of Students as Decision-Making Audience?

While teaching assessments work to quantify assessment of educator as rhetor, educators should be receptive to the needs and wants of their students. Educators should encourage networking between and with their students to foster collaborative learning communities, including affinity groups, and beneficial mentor-student relationships. As early rhetorical acts, educators should appeal to pathos by scheduling meetings with students to become acquainted and understand short-term goals, long-term goals, and concerns. Educators should be careful to respect undergraduates' perspectives and establish an amiable working and learning relationship with them. By getting to know their students and understanding their points of view, educators can help students realize how learning opportunities will benefit them. In addition, educators can model the trusting, congenial, and collaborative relationships that will be important for building rhetorical and disciplinary-specific expertise during their undergraduate experience and in the future.

What Constraints Are Imposed by University Systems?

For the deliberative problem of preparing undergraduates for workplace problem solving, the educator is the rhetor, investigating, and offering opportunities to undergraduates that must be implemented within the university community's systems. To identify, propose, and implement

pedagogical plans, both educators and undergraduates must understand the university's curricular plans and systems (such as for assessment). In addition, tenured or tenure-track educators, whose goals and experience reflect a dedication to advancing disciplinary knowledge, often do not always have experience solving deliberative problems within cross-disciplinary workplace systems and may have difficulty guiding students in these practices.

The undergraduate curriculum structure itself offers both efficiencies and imposes obstacles to the prospect of situated deliberative problems within instruction. As undergraduates proceed along a curriculum path, they typically encounter a modularized structure that emphasizes discrete, discipline-specific knowledge. Understandably, undergraduates benefit from foundational knowledge that is centralized in university disciplinary departments and schools. Yet, due to university's disciplinary focus in most fields of study, a model for a multi-disciplinary, problem-solving system will be acknowledged in only a select few courses. For example in engineering curriculum at my university, a problem-solving process is presented to engineering undergraduates in the first year engineering fundamentals course and then again in courses that support capstone projects in their junior and senior year of instruction.

What Problem-Posing Opportunities Would be Useful?

To guide undergraduates in understanding rhetorical *praxis* in the context of communities, the first step is to recognize undergraduates as curricular apprentices. In this scenario, the university is the undergraduate workplace community, undergraduates are decision makers of their education success, and educators are their mentors within the curricula. I consider curricular apprenticeship to be an organized system of learning opportunities, where educators mentor by drawing from their expertise in building disciplinary knowledge and in rhetorical *praxis* to inform, influence, and guide undergraduates.

I recommend that undergraduate students be required to complete a course that focuses on investigating the practices of a domain or customer base and investigating implementation

systems in the workplace. Students would work collaboratively to engage in open-ended explorations to explore a domain extensively by studying the semiotic features and social practices of the problem's existing system in order to determine the ideal solution. In addition, I confer with Greg, the engineering manager from Gamut, who recommends a course in organizational structures for undergraduates. As Greg noted earlier,

> "I'd love to see engineers come into the workplace with a basic understanding of how corporations are constructed, what the basic functions do, what they need to do their basic jobs, and how to communicate with them. For instance, every large company I know of has management, engineering and technology, finance, marketing, and production/manufacturing. Each functional area will have a different set of expectations, which will most likely be similar to those expectations in other companies or industries. In fact, through my peers at other companies I've yet to see any real discernable differences."

A course focused on disciplinary, domain, or workplace systems would inform undergraduates' investigation of rhetorical situation. Undergraduates would understand power dynamics across workplace systems, learn common workplace processes, and develop image maps of institutional hierarchical structures. With this understanding, students would realize the varied, complex perspectives that should be considered when planning and implementing a situated investigation and then identifying and presenting a solution (or course of action) that will influence decision makers. In addition, reflection of these system features and practices leads to critical thinking and learning, opening up innovative possibilities that extend beyond the existing boundaries of social practice established for the system.

Within this new context of the participatory learning community of practice, students would actively seek perspectives to build understanding, innovate, and advance knowledge through their use of rhetorical *technê*. Rhetorical *technê* would become explicit to undergraduates through their analysis of rhetorical artifacts, through case study, and through guided-experiences with deliberative problem-posing game challenges. Such projects will provide opportunities for practice of rhetorical analysis in unfamiliar contexts and will invite learners to hear and

acknowledge the perspectives of others, whose primary discourses, perspectives, and experiences are different from their own.

What Rhetorical Acts Would Help Me Influence Students?

Whenever possible, educators should plan pedagogical approaches that incorporate the activities, terminology, and technologies frequently used in disciplinary communities, workplace communities, and the undergraduate's current workplace, which is the university community. Educators should reinforce the importance of multiple perspectives and investigative techniques in developing rhetorical *technê*. Educators should help undergraduates understand the legitimacy of perspectives in the many disciplines represented in undergraduate curricula.

When used overtly in instruction, educators can use workplace and disciplinary practices as rhetorical acts for influencing students' engagement, allowing educators to appeal to undergraduate's pathos, ethos, and logos. Educators appeal to logos by providing overt critical framing to explain and demonstrate how workplace techniques and technologies (such as A3 reports) are used to support rhetorical problem solving in the workplace. Educators can use workplace technologies and techniques (such as the A3) to appeal to ethos by demonstrating how educators have planned learning experiences to be relevant and useful in helping undergraduates meet long-term goals, whether in the workplace, academia, or civic contexts. The educator appeals to pathos by situating workplace practices within deliberative, rhetorical problem challenges, and by conveying the exigency for developing rhetorical *technê* for real-world problem solving. Through guided use of workplace practices and rhetorical techniques in multiple disciplines and domains, undergraduates develop rhetorical *technê*. They draw from rhetorical *technê* to engage in situated *praxis* within communities, to identify kairotic moments, and to take an active role in advancing knowledge and innovating in ways that may benefit disciplinary communities, workplace communities, and society.

Who Else Is Investigating This Deliberative Problem?

Although I do not include details here, I propose a series of workshops for educators and curriculum planners from departments across campus who are interested in helping undergraduates prepare for workplace problem solving. The purpose of these workshops would be to provide educators with a collaborative learning environment for learning about workplace and disciplinary practice, rhetorical problem solving, and pedagogical approaches to inspire and guide undergraduates in developing a rhetorical *techné* as preparation for academia and workplace practice. These workshops would pose activity-focused learning environment, as well as peer affinity groups to support educators in understanding apprenticeship learning and the rhetorical situation surrounding preparatory instruction for workplace problem solving. Discussion topics would include rhetorical theory, design processes, workplace problem solving in different contexts, heuristic analysis, and whatever additional topics would support educators in guiding undergraduates. My intention would be to inspire cross-disciplinary partnerships for coordinated instruction.

Conclusion

In this thesis, I have provided pedagogical recommendations that offer undergraduates opportunities to build domain and problem-solving expertise that will help them be successful in today's globalized or local multicultural learning and working environments. Through this research, I have reached a curious observation concerning the perception of success in the context of rhetorical problems, which will never have a right or a wrong answer. What I find intriguing is that although rhetors are aware that they identify a course of action through an investigation that reflects their unique perspective of rhetorical problem, audience, and constraints, they still measure their success on the paradigm of right and wrong. I note two

unstable aspects of rhetoric that make measuring rhetorical success difficult or impossible: evolving rhetorical situation and the instability of invariable knowledge.

I believe that it is a misconceived belief that rhetorical success hinges on the rhetor's ability to persuade a decision-making audience to adopt and act upon their proposed course of action. Certainly, the rhetor will use a heuristic to conduct a systematic investigation. According to Aristotle, the rhetor serves a decision-making audience by offering a proposed course of action, supported by both artistic and inartistic proofs to appeal to pathos, logos, and ethos as a means of influencing and informing the decision maker. Yet, from the perspective of workplace systems, the goal is not to convince a decision maker but instead to enable the decision maker to make the best possible decision.

While the rhetor uses a heuristic to reveal and reflect rhetorical situation, the rhetor will not be able to anticipate all special topics of interest, especially for problems situated in complex workplace systems. Selber (2004) explains how workplace problems are typically deliberative activities that have “socially ambiguous situations" that change over time as well as stopping rules when “time, money or patience runs out" (p. 152). As a result, the rhetor's acts and artifacts may not successfully result in a proposed course of action but these acts and artifacts will build knowledge nonetheless. Potentially, this knowledge could enable the decision maker audience to deliberate and identify an alternative solution that is better suited for the evolved rhetorical situation. Yet, the rhetor's acts and artifacts will successfully build knowledge and increase understanding, whether the decision maker chooses to implement the proposed action, redesign the action, depart sharply from the proposed solution or not act at all.

Another challenge in measuring rhetorical success is that contributing and advancing invariable knowledge can only be seen after an indeterminate amount of time. The concepts of rhetoric enable us to extend our understanding of "invariable" knowledge as a means to advance knowledge and design. One fallacy, however, is in believing that acceptance of invariable

knowledge is permanent. What we often consider as facts, truth, and real are stable understandings until they are proven otherwise. When we look back retrospectively through history, we can see how "invariable" knowledge, or knowledge accepted as true and stable by a community of practice, may be disproven. For example, scientists as rhetors have promoted their ideas through rhetorical acts, which were accepted as "invariable" knowledge at the time, only to be discounted through subsequent efforts to advance knowledge. Yet, once again, even if invariable knowledge is later considered as false, the rhetor may have successfully contributed to advancing knowledge by inspiring others. In order to advance knowledge, we need to be aware of knowledge that is considered to be invariable so that we can build up on it.

Rhetoric has incredible potential for empowering us to serve society and to meet the challenges of the future. The pedagogical approaches I have proposed in this thesis are meant to encourage university educators to inspire undergraduates to become life learners with empowering, rhetorical expertise. I have suggested how educators might rearticulate pedagogical practices, offer problem-posing opportunities, and foster collaborative learning relationships in ways that help undergraduates realize the exigency, understand the *technê*, and engage in the *praxis* of rhetorical problem solving. Perhaps more importantly, I encourage educators as rhetorics to anticipate the needs of students and workplaces (in the context of rhetorical situation) and design overt rhetorical acts. These acts would provide students with an understanding of exigent problem and demonstrate how the proposed pedagogical approach represents a suitable course of action.

I have focused my suggestions on pedagogical approaches that educators might employ to help undergraduates understand rhetoric, not only as a *technê*, or flexible technique for rhetorical problem solving, but also as *praxis*, where students develop the practical wisdom to situate themselves rhetorically within a professional community in order to consider multiple perspectives and contribute to productive decision making. To align with the beneficial aspects of

rhetorical problems, our measures of rhetorical success at the university may need to be redefined. I suggest that we consider the success of educators and students to include the persistent investigation of rhetorical situation as well as the overt expression of exigency, investigative path, and proposed course of action. Long term success will be best realized in our diligence to influence, inform, advance, consider, critique, innovate, and provide service to each other.

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Appendix

Appendix A: Initial Questions for Manager at Megalith Company

General Company Information

- What type of work does your company do?

Engineering Assignments

- What kinds of projects do engineers work on? Are they assigned?
- Do these projects have a problem and constraints? Who are the decision-making audience? (How are these projects rhetorical?)
- How do engineers communicate to their decision-making audience? Reports? Meetings? Standard report forms?

New Engineering Graduates

- What challenges do new engineers have completing their projects successfully?
- How do new engineers learn in your company? Resources? Training programs?

Appendix B: Example Emailed Questions to Support Analysis of A3 Form

Activity Awareness

- Are projects assigned?
- What does the engineer know about the product and customer?
- How do engineers get help?

Audience

- Who reviews the A3?
- Who are the decision-makers? Who are the stakeholders?
- How else does the engineer communicate to these decision-makers and stakeholders?

Heuristic Evaluation

- How are constraints and requirements established?
- What do these acronyms and terms mean?
- How does the engineer decide which tests must be conducted?
- What makes an A3 report successful? Unsuccessful?
- Why are technical specifications expected in the incomplete report but not the complete?

Appendix C: Questions for Phone Interview with Megalith's Engineering Design Manager

General

- What work processes take place at your site?
- What are the other locations of your company and what work takes place there?
- Do people at your site have contact with vendors? customers? other?
- What types of documentation takes place within the company?

Collaboration and Global Collaboration

- What types of collaborative projects take place in your company?
- How do you train your employees?
- How does your company encourage teamwork and collaboration?
- How do management styles differ between your company's locations?
- How does management reward employees? What work is admired among peers?
- How are big deadlines handled?
- How do relationships between engineers differ in the locations outside the US?
- Does your company encourage teamwork and collaboration? How?

Problem Solving and Use of Rhetoric

- What cultural and institutional values impact engineering design at different locations?
- How do engineers address the needs of audience(s) of the A3 report?
- How do engineers consider rhetorical situation in their problem solving and discourse?
- How do engineers persuade audiences through their use of discourse?
- How are the problem-solving skills different between engineers in the two countries?
- What are the problem-solving strengths and weaknesses of US engineers?
- How are engineers trained in the US? How are engineers trained in your other locations?
- What are obstacles to training engineers in the US?

Reporting and Communication at Megalith:

- How are A3 reports used in your company? What other types of reports or documentation are used?
- Who is responsible for designing the custom format for A3 report?
- Describe the relationship between engineer and the recipient of the A3 report.

Appendix D: Questions for Phone Interviews with Additional Engineering Managers

General Company Information:

- How are engineering projects conducted at your company?
- Describe the organizational structure.
- Are their design guidelines (forms) for decision-making reporting? If so, who is responsible for designing forms?
- Is writing support available to engineers?

Values in the Workplace

- What types of discourse do engineers engage?
- What features of work are admired and rewarded by management? Among peers?
- How does your company encourage teamwork and collaboration?
- How are engineers trained? What are some of the obstacles to training engineers?
- What roles do networking and seniority play in the working culture?

Problem Solving and Awareness of Rhetorical Situation

- How do engineers address the needs of audience(s) in their persuasive communications?
- How do engineers address rhetorical situation in their problem solving and discourse?
- How might cultural and institutional values impact engineering design?
- What are problem-solving strengths and weaknesses of US engineers? New engineers?

Hiring Qualified Engineers

- What impresses you on a resume and during an interview?
- How do you determine an applicant's technical expertise? What else is important?
- What advice do you have for interviewees?

Preparing for the Engineering Workplace

- What advice do you have for undergraduate students?
- What education experiences do you think are particularly beneficial for engineering students?
- How can universities better prepare students for the engineering workplace?

Appendix E: Megalith A3 Report Template with Instructions

The Megalith manager provided an A3 report template for this research, which has been modified as necessary so that the manager and company remain anonymous. While discussing the A3 template during research study interviews, the Megalith manager identified implicit questions that engineers consider as a means of conducting assignments to meet Megalith needs. These questions prompt the engineer to understand the rhetorical situation by conducting a heuristic evaluation of their assignment.

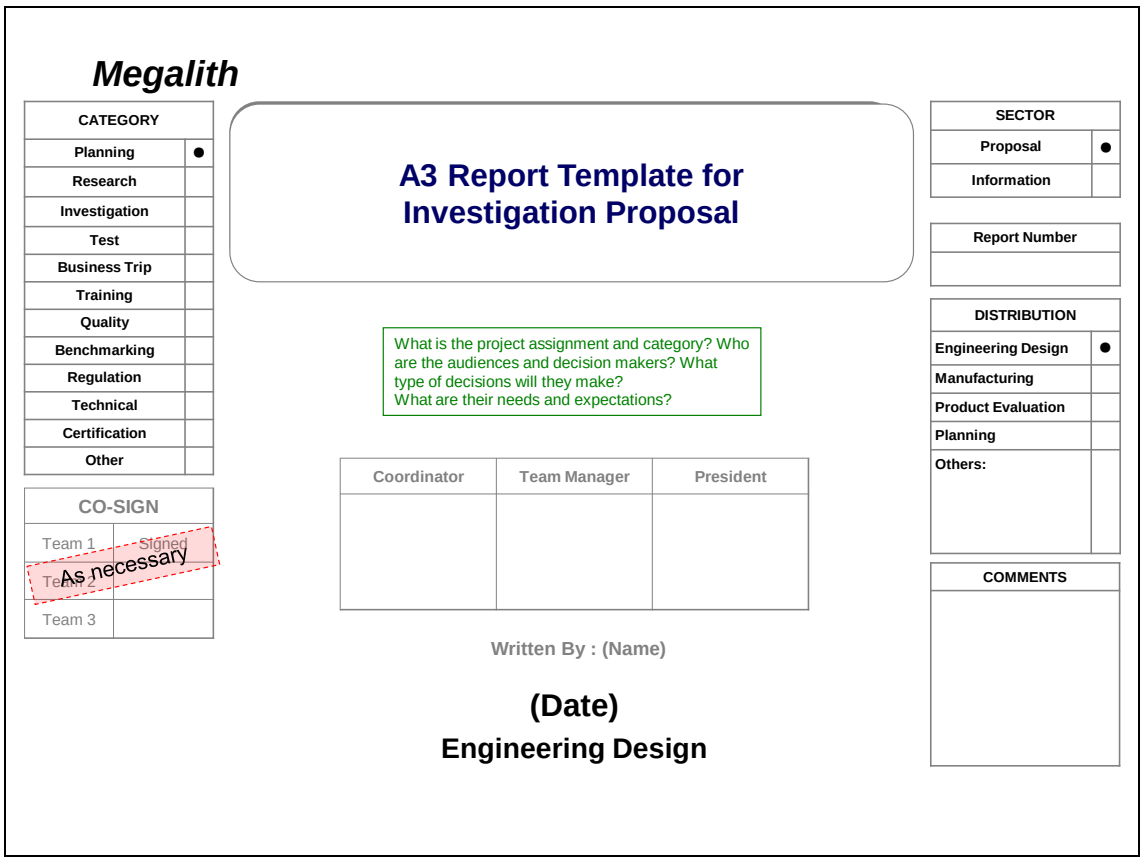


Figure E.1. Cover page (page 1) of Megalith A3 report template with implicit heuristic questions added in green type in the manager's own words.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

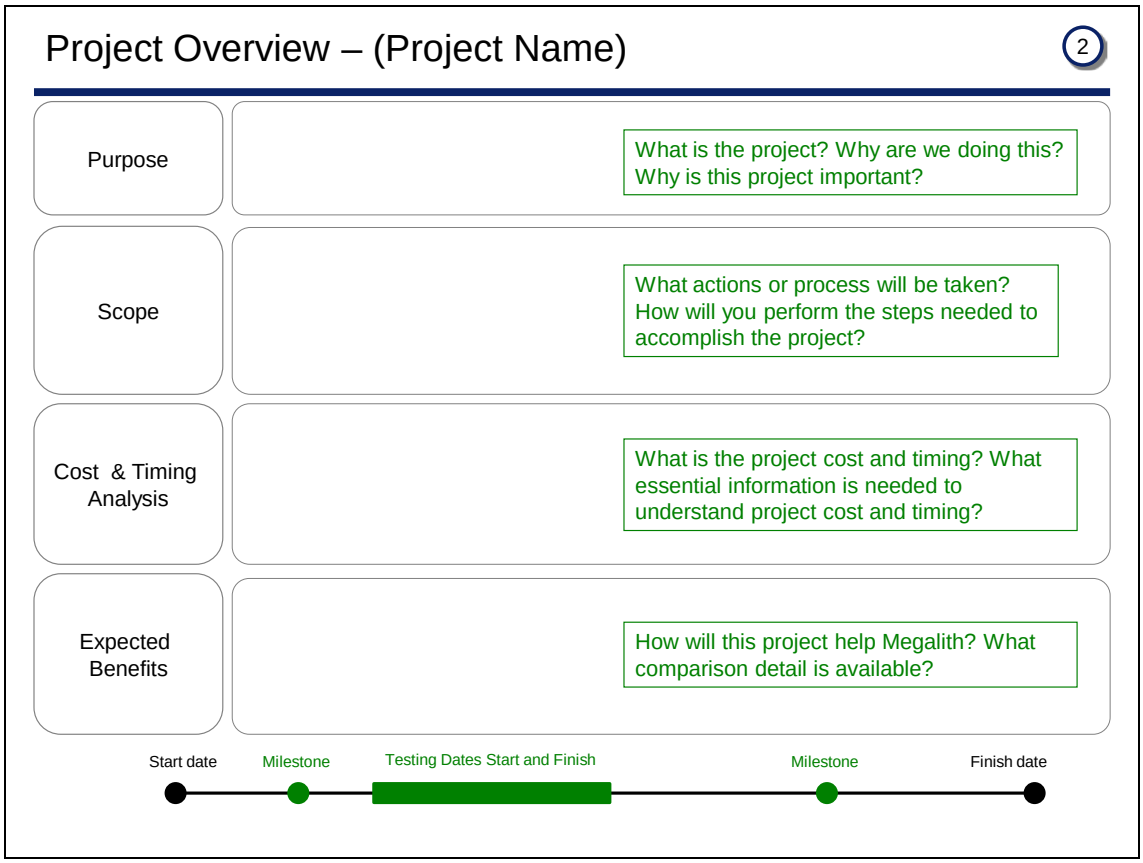


Figure E.2. Project overview (page 2) of Megalith A3 report template with implicit heuristic questions added in green type in the manager's own words.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

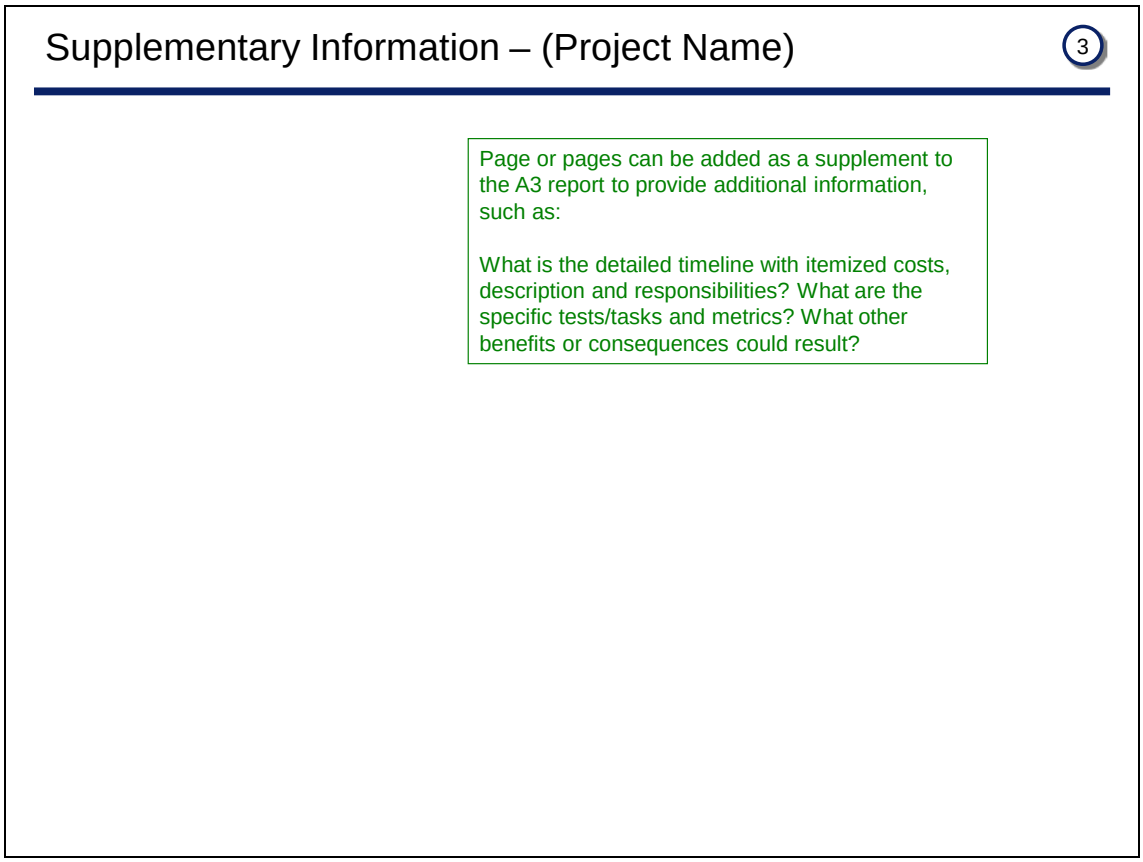
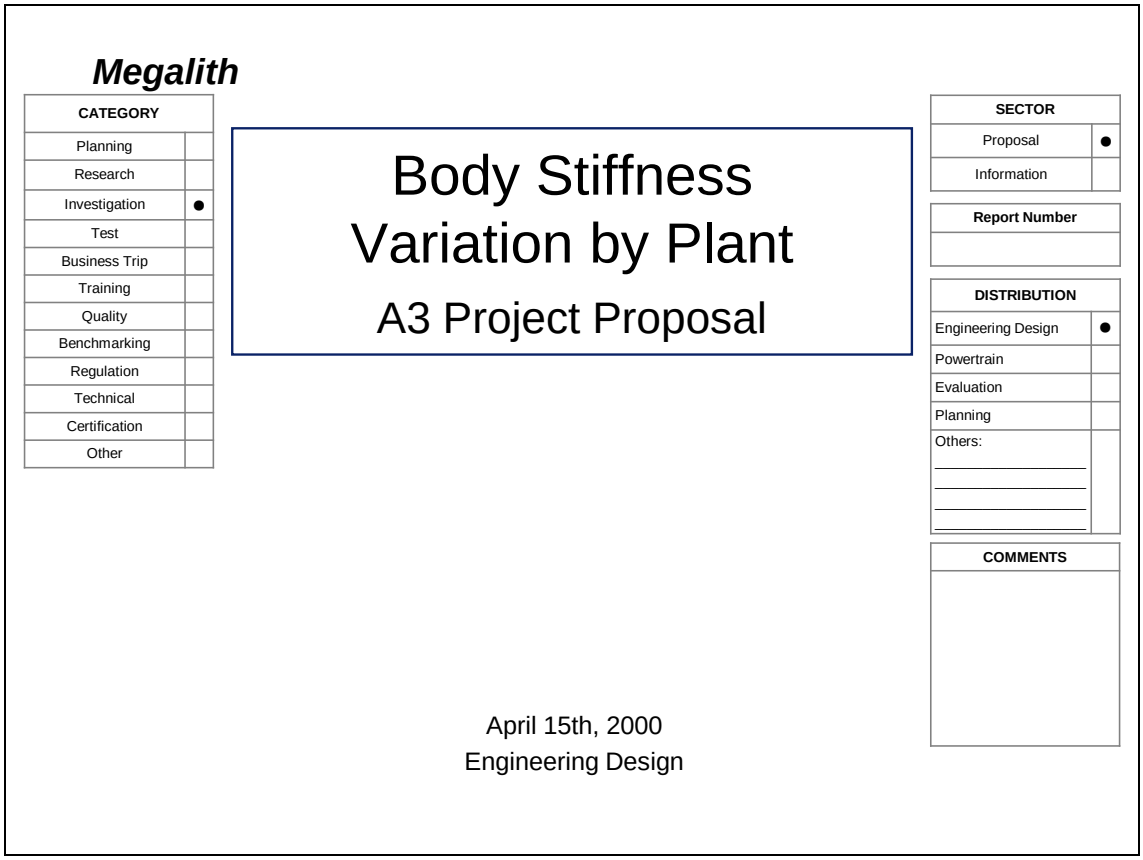


Figure E.3. Supplementary information (page 3) of Megalith A3 report template with implicit heuristic questions added in green type in the manager's own words.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

Appendix F: Complete Megalith A3 Report

The Megalith manager provided a complete A3 report for analysis, which was modified for Appendix F as necessary so that this manager and company remain anonymous.



Megalith

CATEGORY	
Planning	
Research	
Investigation	●
Test	
Business Trip	
Training	
Quality	
Benchmarking	
Regulation	
Technical	
Certification	
Other	

Body Stiffness Variation by Plant

A3 Project Proposal

SECTOR	
Proposal	●
Information	

Report Number

DISTRIBUTION	
Engineering Design	●
Powertrain	
Evaluation	
Planning	
Others: _____ _____ _____ _____	

COMMENTS

April 15th, 2000

Engineering Design

Figure F.1. Cover page (page 1) of complete Megalith A3 report.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

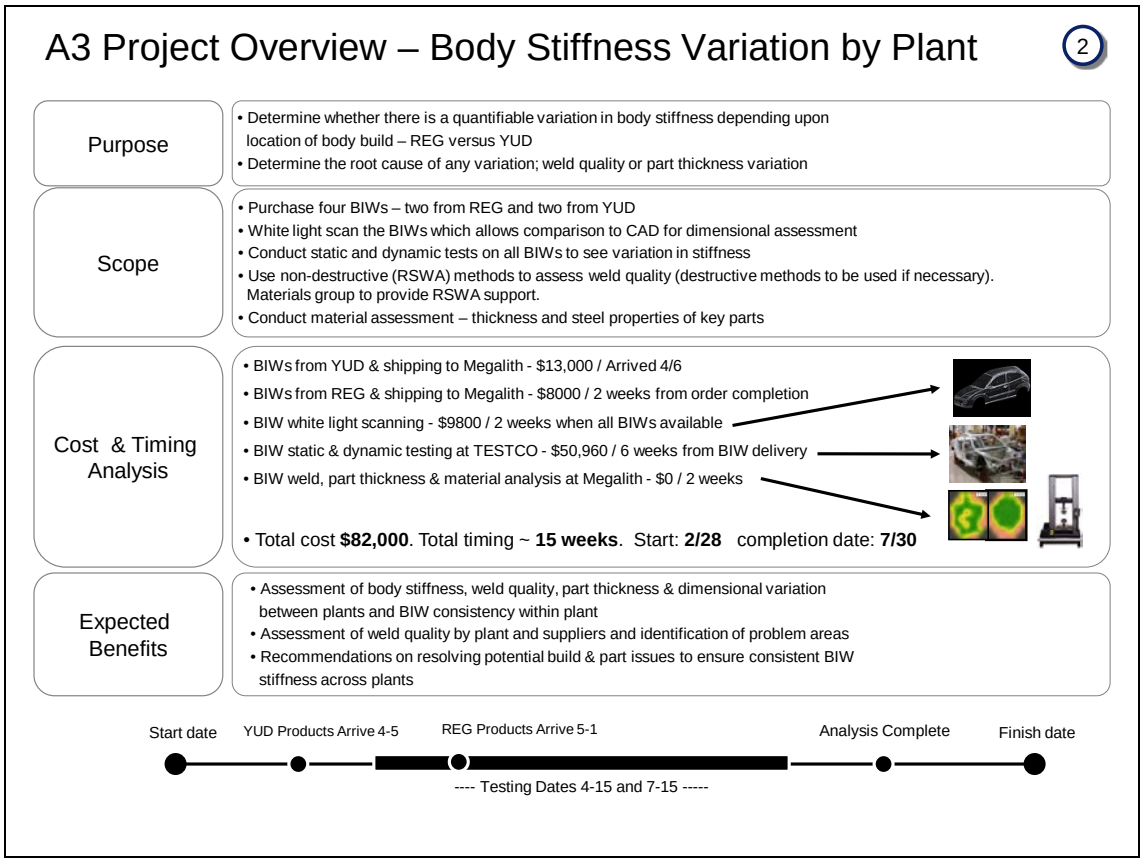


Figure F.2. Project overview (page 2) of complete Megalith A3 report.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

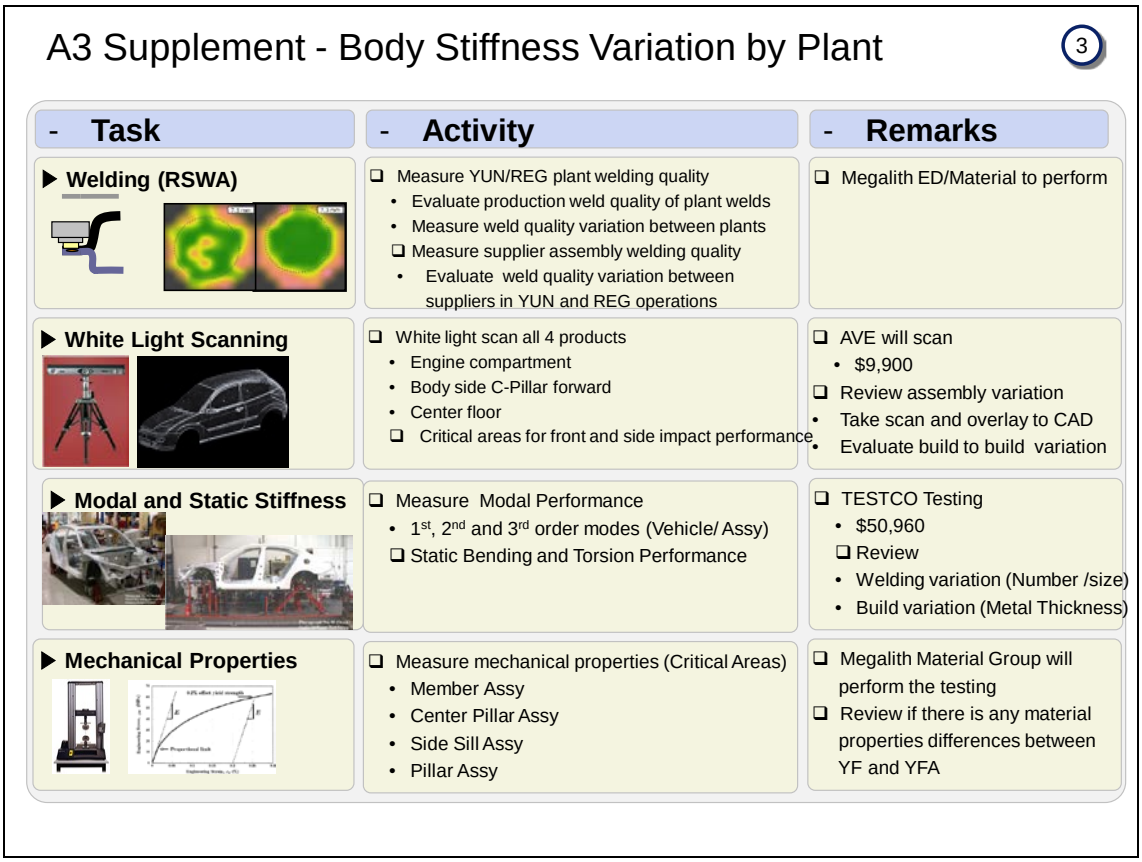


Figure F.3. Supplementary information (Page 3) of complete Megalith A3 report.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

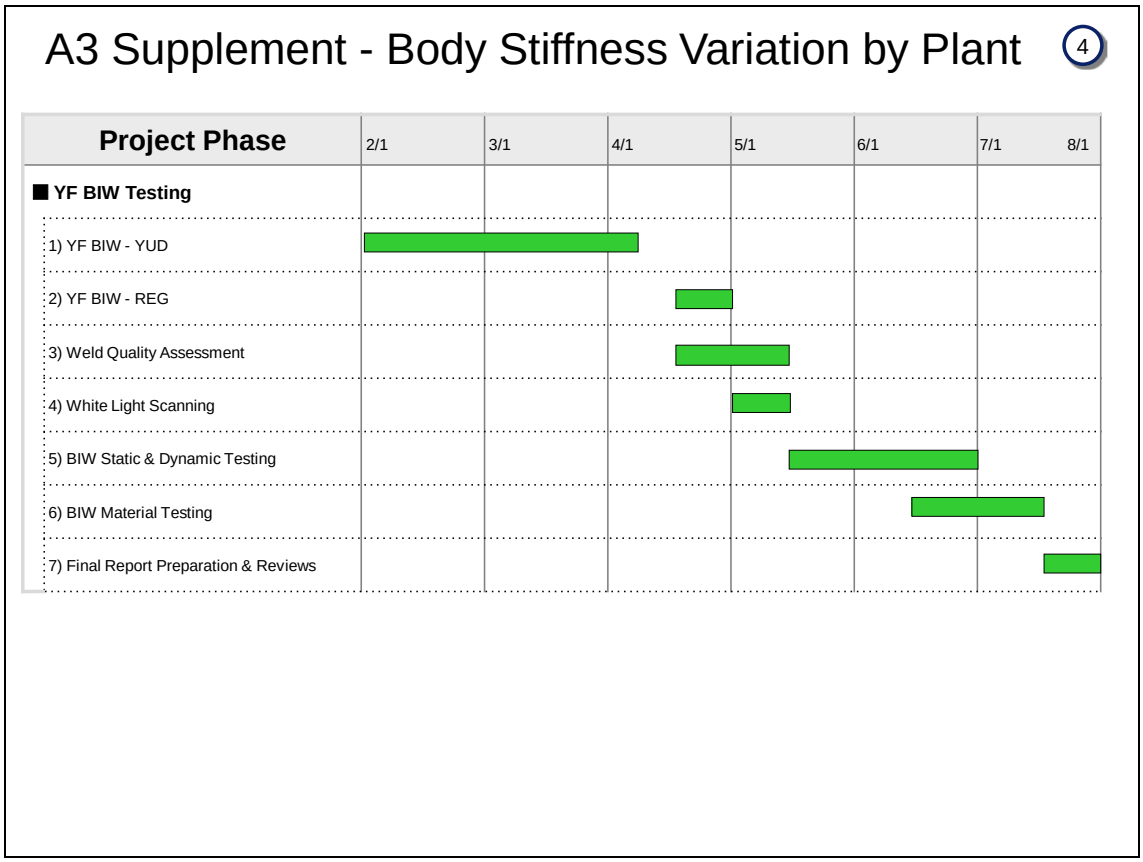


Figure F.4. Supplementary information (page 4) of complete Megalith A3 report.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

Appendix G: Incomplete Megalith A3 Report with Manager's Comments to Engineer

The Megalith manager provided an incomplete A3 report for analysis, which was modified for Appendix G as necessary so that this manager and company remain anonymous. This report contains feedback comments from manager to engineer, identified in red type.

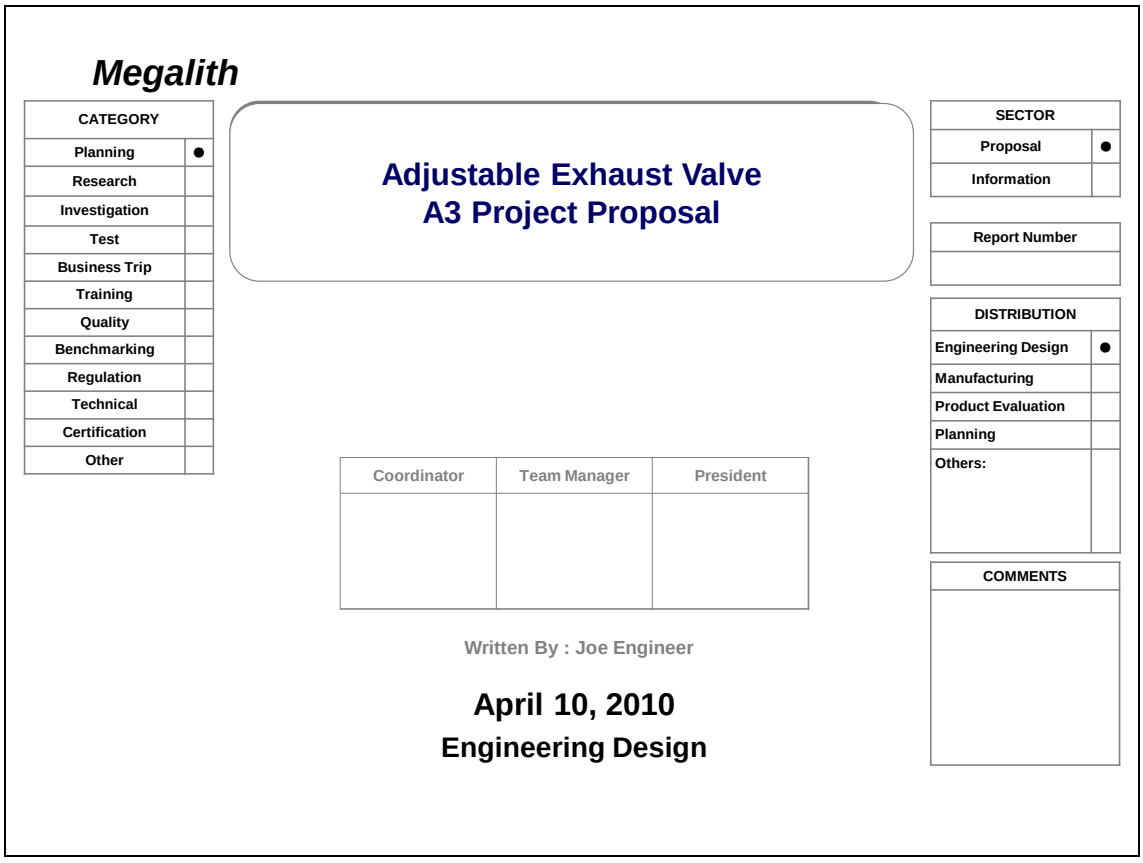


Figure G.1. Cover page (page 1) of incomplete Megalith A3 report.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

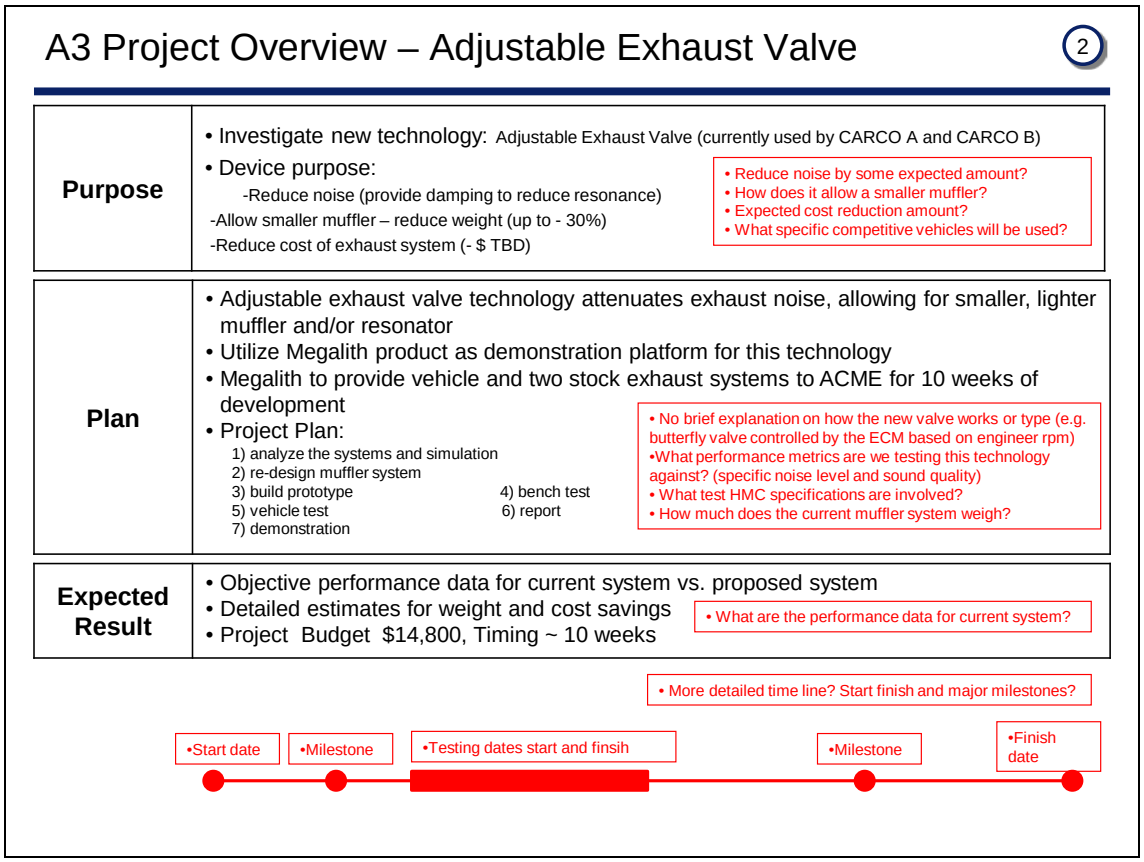


Figure G.2. Project overview (page 2) of incomplete Megalith A3 report with manager's feedback to engineer identified in red type.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.

A3 Supplement – Adjustable Exhaust Valve & Project Timing 3

Project Timing Plan

ID	Task Name	Duration
3	**total**	**67 days**
4	Megalith provides product	0 days
5	Analysis of existing system	3 days
6	Benchmark vehicle	4 days
7	Acoustic Design	1 wk
8	Acoustic Simulation	1 wk
9	Build prototypes	2 wks
10	Test	6 days
11	Build prototypes	2 wks
12		3 days
13		4 days
14		1 day
15		
16		

This whole page is not acceptable
a. No detailed time line. How do I know when the project starts and stops?
b. No detailed description of the technology. Just a picture of the valve.
- Where is it in the muffler system?
- How does it work and when?

c. What specific frequency range does it operate?
… needs many more details……

Supplier Overview

ACME's Adjustable Exhaust Valve Valve enables lighter mufflers while dampening noise pollution. One stubborn contributor to vehicle weight has been the muffler. Until now, mufflers needed to remain relatively large to dampen exhaust noise, especially low-frequency sounds.

Normally, muffler efficiency is not as effective when dealing with low-frequency exhaust. Therefore, mufflers are made larger to address these low-frequency sounds.

The ACME valve provides broadband noise reduction, however, and is equally effective. As a result, smaller mufflers can be used without fear of permitting low-frequency noise. Adjustable Exhaust Valve attenuates that noise.

Therefore, this valve allows vehicles to be equipped with mufflers that are up to 35 percent lighter than conventional mufflers.

Figure G.3. Supplementary information (page 3) of incomplete Megalith A3 report with manager's feedback to engineer identified in red type.

Note: This figure was adapted from a report provided by an anonymous research subject, referenced here as Mervin from the Megalith Automotive Company.