2008

How Are NASA Engineers Motivated? An Analysis of Factors that Influence NASA Goddard Engineers' Level of Motivation

Howard Eric Kea

Antioch University - PhD Program in Leadership and Change

HOW ARE NASA ENGINEERS MOTIVATED? AN ANALYSIS OF FACTORS THAT INFLUENCE NASA GODDARD ENGINEERS' LEVEL OF MOTIVATION

HOWARD ERIC KEA

A DISSERTATION

Submitted to the Ph.D. in Leadership & Change Program
of Antioch University
in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy

July, 2008

This is to certify that the dissertation entitled:

HOW ARE NASA ENGINEERS MOTIVATED? AN ANALYSIS OF FACTORS THAT INFLUENCE NASA GODDARD ENGINEERS' LEVEL OF MOTIVATION

prepared by

Howard Eric Kea

is approved in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Leadership & Change.

Approved by:

Jon Wergin, Ph.D. Chair	date
Elizabeth Holloway, Ph.D. Faculty Reader	date
Carol Baron, Ph.D. Faculty Reader	date
Charles Seashore, Ph.D. External Reader	date

This work is dedicated to the memory of my father

Andrew Millard Kea, Capt. USAF

Who let nothing deter him from pursuing his life's dream:

"To fly airplanes…"

Acknowledgments

There are many people I would like to thank for supporting me throughout this journey. I had the gifts of listening ears, coaching, cheerleading, shoulders to cry on, and laughter from family members, friends, fellow cohort members, and faculty. I am truly grateful to each of them for encouraging and challenging me to dig deeper, and to slow down when I needed to.

Thank you to Dr. Laurien Alexandra, for conceiving and birthing this fabulous program, and for inviting me on this journey and encouraging me along the way. Thank you to Dr. Elizabeth Holloway, my advisor and committee member, for guiding me along the journey, encouraging me along the way, and helping me to get clarity on my dissertation. Thank you to Dr. Jon Wergin, my committee chair, for guiding me to a manageable dissertation topic and allowing me to put it in my voice-- you also make a damn good martini as well! Thank you to Dr. Carol Baron, committee member, ILA mentor, and my statistics instructor, for the many hours on the phone and at your house in helping me to understand my data and introducing me to the "art" of quantitative analysis. Thank you to Dr. Charles Seashore, external reader, for your insightful feedback on my dissertation. Special thanks to Dr. Michael Broom, my coach and ILA mentor, for stretching me well beyond what I thought possible which led me to finding my own voice.

Thank you to Cohort 1: Scott, Karen, Mia, Beth, Bruce, Peggy, Miriam, and Bill, we were the nine pioneers who stuck it out to the end. Thank you for the love, support, and life- long friendship.

Thank you to my NASA family and particularly to Denise Davis, my boss, for advocating on my behalf for the NASA Study Fellowship that enabled me to complete my dissertation and to directors, Ron Brade and Orlando Figueroa for granting me permission to conduct my

research at NASA Goddard. Thank you to all the engineers who participated in the study and made this work possible.

Thank you to my mother for planting seeds when I was a child that education is the key to success in life and to my sister, Dr. Karen Kea for her quiet inspiration. Thank you to my children Chase and Mallory, for giving Dad time to study and for your bright smiles that bring me joy each day. And finally, thank you to my wife Nikki, for sticking by my side through my personal struggles. You are my best friend. This PhD program brought us together and without your unconditional love and support I could not have completed this journey.

Abstract

NASA is an organization known for pushing the envelope of engineering and scientific achievement. It can be argued that engineers working for NASA are intrinsically highly motivated due to the nature of the work and the mission of NASA. This study explores how supervisor behaviors, both intrinsic and extrinsic and demographic factors influence motivation of NASA Goddard engineers in their current environment. Recent Congressional and Office of Management and Budget (OMB) policies, such as *full cost accounting*, levy strict oversight of project spending. As a result of these policies, NASA engineers must now focus their attention on getting assigned work on funded projects in addition to pursuing technical innovation and creativity. The literature is replete with previous studies on motivation of engineers and scientists. These studies investigated Maslow (1970), Vroom (1964), Herzberg (1971), and Deci's (1975) theories of motivation. Today, the workplace is much more diverse with regard to race, gender, and age. A web-based survey was used to collect data from a sample of engineers at NASA Goddard Space Flight Center. 260 out of 583 engineers responded to the survey. 238 cases provided useable data for analysis. A hierarchical regression analysis revealed the demographic categories of females and non-whites did not significantly predict the level of motivation of engineers. Age was a significant factor influencing motivation. The age group of 39 and under had less of an influence on motivation and the age group of 40 and over had more of an influence. The over 60 age group had a very significant positive influence on motivation. Other significant factors influencing motivation were: supervisor behaviors, intrinsic factors such as feedback and competence, and extrinsic factors such as benefits, rewards and promotions. The results support the argument that NASA engineers are motivated by getting feedback from their immediate project supervisor, that they feel competent in their jobs, and that the benefits, rewards, and promotions fairly reflect their contribution and loyalty to the mission of NASA.

TABLE OF CONTENTS

List of Tables

List of Figures

Chapter I: Introduction

Problem Statement

In the early days, rocket engineers were driven by an incredible vision to break boundaries and make new discoveries, and this attracted many in the engineering profession to work for the National Aeronautics and Space Administration (NASA). Because of recent political and budgetary events and the wide demographic diversity of the engineering workforce which is very different from the early days, NASA has moved to a different paradigm for managing engineers' work. The implications explored in this study are the deleterious effects on the intrinsic motivation of a very demographically diverse engineering workforce, who now must focus on competing for work versus pushing the envelope of technology in pursuit of new discoveries. NASA's cultural environment has changed. Can NASA's engineers still be motivated to be creative and innovative in an environment where the bottom line is to cut spending?

History and Culture of NASA

NASA's beginnings are often linked to the pioneering efforts of two great rocket scientists, Robert Goddard and Wehrner von Braun. When Robert Goddard conducted his pioneering work in rocketry at the beginning of the 20th century, he worked primarily alone. According to Lehman (1963), "he remained a solitary, mustering a few mechanics to help him … among the voluble rocket fraternity, Dr. Goddard was considered a curious and withdrawn genius who would neither join the team of others nor permit them to join his" (p. 3). In 1930, Dr. Goddard successfully launched a liquid fueled rocket which was a major step in achieving his dream of space flight. In contrast to Dr. Goddard, another rocket engineer, Wehrner von Braun, passionately believed in teamwork. According to Walters' (1964) autobiography of Dr. von Braun, "Dr. von Braun believes firmly that there is only one way to succeed in modern

technology: through teamwork." (p. *xx*). Even though these great pioneers approached their life's passion from different perspectives and were born 30 years apart--Dr. Goddard in October 1882 and Dr. von Braun in March 1912--their inspiration, passion, and drive were seeded by studying Sir Isaac Newton's Laws of Physics, and their imaginations were fueled by reading Jules Verne's 1865 novel, *From Earth to the Moon*. Drs. Goddard and von Braun's technical expertise and visionary leadership became the pillars of America's space program and NASA's creation.

NASA, the successor to NACA,[1] was established by President Dwight D. Eisenhower on October 1, 1958. NASA was created in direct response to the October 4, 1957 Soviet Union's launch of *Sputnik*, the first satellite to go into orbit around the earth. Goddard Space Flight Center was formed seven months after the establishment of NASA, on May 1, 1959, with about 160 researchers from the Naval Research Lab Vanguard project[2]. NASA Goddard's engineers were very different from today's engineering workforce. According to John Martin, who was one of the original 160 engineers and still works at NASA Goddard today, there was very little diversity among the engineers (Martin, personal communication, February 15, 2007). He stated that the only female employees were secretaries, there were no female or African American engineers among the 160, and just one Asian/Pacific Islander engineer. NACA's annual budget in 1915 was $5,000. According to the National Science Foundation (NSF) (2006) report, NASA's 2005 actual research and development (R&D) funding level was nearly $17 billion. This represents a significant investment in research and development of space exploration.

[1] The National Advisory Committee for Aeronautics (NACA) was a U.S. federal agency founded on March 3, 1915 to undertake, promote, and institutionalize aeronautical research. On October 1, 1958, the agency was dissolved, and its assets and personnel transferred to the newly created National Aeronautics and Space Administration (NASA).

[2] The Naval Research Laboratory (NRL) between 1955 and 1959 conducted the first American satellite program called Vanguard. When the National Aeronautics and Space Administration (NASA) was established in 1958, the NRL Vanguard group, a total of approximately 160 scientists and engineers, became the core of its spaceflight activities at the NASA Goddard Spaceflight Center in Greenbelt, MD.

NASA's budget is primarily composed of R&D funding which directly supports NASA's primary mission of space exploration through discovery and innovation.

To further highlight the investment that the U.S. has made in research and development, specifically in space exploration, consider NASA's investment in human capital. The NSF's (2005) report on Federal Scientists and Engineers provides an overall perspective of the total number of federally employed scientists and engineers between 1998 and 2002. According to this report, in 2002, the U.S. Federal Government employed a total of 206,824 scientists and engineers, with 120,824 scientists and 85,358 engineers. The table below gives a demographic breakdown of the 85,358 engineers.

Table 1.1

Demographic Breakdown of Total U.S. Federal Government Employed Engineers

Group	Total
Male	75,636
Female	9,719
White	67,772
Asian/Pacific Islander	9,169
Hispanic	3,969
Black	3,702
American Indian/Alaskan Native	658
Other	11

Of the total 206,182 federally employed scientists and engineers, 84,118 are employed in the South Atlantic Region of the United States consisting of Delaware, District of Columbia,

Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida. Within this region, Maryland and Washington, DC have the largest number of federally employed scientists and engineers, 20,592 and 27,147 respectively. This comprises 23% of the total as of 2002. It represents the largest concentration of engineers and scientists in the U.S. and is the focal area of this research.

How does NASA rank against the NSF statistics? Out of 20 federal agencies, NASA is the fifth highest employer of scientists and engineers with more than 10,000 on the payroll, about 10% of whom are engineers. NASA makes up 11.6% of the total federal engineering workforce.

These scientists and engineers are spread across ten NASA Centers. They include NASA Headquarters, Washington, DC; Ames Research Center (ARC), San Jose, CA; Glenn Research Center (GRC), Cleveland, OH; Langley Research Center (LaRC), Hampton, VA; Dryden Research Center (DRC), Edwards AFB, CA; Marshall Spaceflight Center (MSFC), Huntsville, AL; Stennis Space Center (SSC), Bay St. Louis, MI; Johnson Space Center (JSC), Houston, TX; Kennedy Space Center (KSC), Cape Canaveral, FL; and Goddard Space Flight Center (GSFC), Greenbelt, MD, where I currently work. In addition, the Jet Propulsion Laboratory (JPL), Pasadena, CA is a federally funded Research and Development Center, whose employees are not federal employees but contractors and are not included in the federal employee reports. From a demographic perspective, NASA has grown to be a very diverse agency relative to how it looked in 1958.

According to the NASA (2007) workforce diversity database, the engineering workforce demographic breakdown is as follows:

Table 1.2

NASA 2007 Engineering Workforce

Group	Total
White	7,063
Asian/Pacific Islander	767
Black	604
Hispanic	501
American Indian/Alaskan Native	55

This study will specifically focus on the engineering workforce at the GSFC. According to the NASA (2007) Workforce online database, in 2002, NASA GSFC had a total of 1,802 scientists and engineers, with 1,428 engineers and 374 scientists. Goddard employs 17% of the total NASA scientists and engineers.

The demographic breakdown of the engineering population at Goddard is indicated in the table below.

Table 1.3

GSFC 2007 Engineering Workforce

Group	Total
White	1,057
Asian/Pacific Islander	161
Black	137
Hispanic	70
American Indian/Alaskan Native	3

Goddard is one of the most diverse of the ten NASA Centers and has an active diversity program, consisting of a Diversity Dialogue Program (DDP) in which volunteers participate in facilitated discussions about religion, race, gender, and sexual orientation. GSFC also has a full-time diversity Executive Secretary responsible for the center-wide diversity initiative.

The scientists and engineers today are as passionate as their predecessors and have dedicated much of their lives to the pursuit of space exploration. But this passion has also come at a great sacrifice and human cost. NASA experienced its first tragic accident during the launch pad test of Apollo 1, in which a fire caused by a short circuit took the lives of three astronauts on January 27, 1967. Nineteen years later almost to the day, the Space Shuttle Challenger exploded shortly after lift-off on January 28, 1986. Seven crewmembers were lost, one of whom was a school teacher, the first civilian in space. The subsequent accident investigation revealed that *O-Rings* had failed to keep hot gases from igniting the shuttle's external fuel tank. Seventeen years after the Challenger accident, the Space Shuttle Columbia broke apart when re-entering earth's atmosphere after a successful mission in space, on February 1, 2003. Seven crewmembers lost their lives. The subsequent accident investigation revealed that insulating foam broke off during launch and damaged the heat-resistant tiles that protected the left wing from high temperatures, causing it to fail during re-entry. Each of these accidents resulted in NASA instituting new safety procedures and new management processes. However, it was also discovered after the Columbia accident investigation that NASA's culture was also a major contributor to both shuttle accidents--a culture that treated potential catastrophic risks as acceptable and normal (NASA, 2003).

The investigation board of the Space Shuttle Columbia accident acknowledged that many accident investigation boards fall short in that they identify either the technical cause or operator error, but invariably these are not the entire issue. Such was the case with all of NASA's

catastrophic accidents. The NASA Columbia Accident Investigation Board reports that "the NASA organizational culture had as much to do with the accident as the foam" (2003, p. 97). The Rogers Commission selected by President Reagan to investigate the Challenger accident, (as cited in NASA, 2003), identified the failure of the *Solid Rocket Booster* joint and seal as the physical cause of the accident. However, the Commission concluded that "the decision to launch the Challenger was flawed . . . and that NASA management came to see the problems as an acceptable flight risk--a violation of a design requirement that could be tolerated" (p. 100). Note the parallel to the conclusion of the Apollo 1 Investigation Board (NASA, 1967) concluded that the Apollo team failed to give adequate attention to crew safety. In all three cases there is evidence that the culture at NASA was complacent regarding certain risks to crew safety. There was also evidence that engineers in each case were motivated to raise concerns of safety but were overridden by their management, most likely because of the cost and schedule impacts to the manned spaceflight program.

Perhaps there were external drivers that placed pressure on NASA managers to meet unrealistic schedules and downplay the risk of space travel. For example, in the case of Apollo 1, the priority was the race to beat the Soviet Union in putting humans on the moon. In the case of Challenger, the emphasis was on projecting to the public that the space shuttle travel was routine and safe for civilians. Finally, in the case of Columbia, the importance in giving the appearance of operating and maintaining the space shuttle safely outweighed the reality of a project that was woefully under-funded.

Projecting this unrealistic public image creates a tension among NASA engineers between being viewed as team players or as whistle blowers. This raises a serious concern--are NASA engineers being asked to compromise their technical expert opinions in the face of budget, schedule, and political pressures? Does the NASA culture affect employees' attitudes

toward their work and their organization? To address this and other concerns, NASA Goddard took the initiative to learn more about the state of its culture.

In 1997, 1999, and 2002, NASA Goddard conducted a series of culture surveys. These were a joint effort between GSFC and W. Warner Burke Associates, Inc. to investigate what was going well and what needed improvement. A 150- item questionnaire, based on the Burke-Litwin model,[3] was used. The model provided a conceptual framework for organizing and interpreting the data using 12 categories: external environment, mission/strategy, leadership, organization culture, structure, management practices, systems, skills/job match, work unit climate, individual needs and values, motivation, and individual and organization performance. The survey results for all three surveys indicated that motivation was the highest ranked category. According to GSFC, "The GSFC employees are highly motivated, dedicated to success, and loyal to GSFC and NASA" (1999, p.13). GSFC (2003) results indicate that "Goddard employees are unsurpassed in their dedication to doing their jobs well and getting things 'right'" (p. 12). Generally, all three surveys indicate that GSFC employees are highly motivated. The employees feel they are making a contribution to Goddard's success.

In the past five years since these surveys were conducted, however, significant organizational changes have taken place. One of these changes is *full cost accounting*. Full cost accounting was enacted by federal law in 1998 requiring federal agencies such as NASA to account for full cost of programs and projects beginning fiscal year 1998 (NASA, 1999). NASA defines *full cost* "to mean that each program and project budget estimate includes all of the program and project direct and indirect costs, including all civil service salaries and other infrastructure costs" (NASA, 2005, p. 1). What this means is that civil servants' salaries are

[3] The Burke-Litwin model provides a conceptual framework for organizing and interpreting organizational data. The model was adapted from "A causal model of organizational performance and change", W. Warner Burke and George H. Litwin, Journal of Management, 1992, Vol. 18.

based on real work on projects rather than General and Administrative (G&A) overhead expenses. Before full cost accounting, engineers at NASA got paid whether they were working on a project or not. Under full cost, if an engineer is not assigned to a project, theoretically that engineer would not get paid. This would not actually happen in practice because the engineer would get paid out of the Center's overhead fund source. However, a lot of scrutiny would be placed on this engineer's ability to be assigned work on a project. This results in managers focusing a large part of their attention on finding work for engineers, which may be problematic for younger engineers who lack experience and older engineers whose skills may not be current. As a result, employability categories have been developed to help manage this issue.

Three categories have emerged regarding an engineer's employability: *transition, critical skill available for work,* and *available for work. Transition* refers to engineers who were supporting a project, or multiple projects, fulltime and were considered a critical asset to the project that ended, or they are temporarily between projects. *Critical skilled* engineers are those who are not assigned a project but possess skills or competencies that are considered critical to NASA Goddard's mission. The third category is *available for work.* These are engineers classified as being difficult to place for a broad range of reasons. Examples include that their skill set is not mission critical, they are viewed as not being a full contributor, they have been removed from projects, or they are low performers, whistle blowers, dead weight, or any number of other negative attributes. If any engineer in this category remains on the overhead rolls for an extended period of time, steps are often taken to force retirement or removal from government service for poor performance. Engineers are now motivated to focus on getting assigned to projects that have longer term stability but are less exciting and intrinsically rewarding. Has this policy created a shift in the culture that significantly affects the work environment for engineers

at NASA Goddard? The goal of this study is to empirically investigate the shift in culture and other effects on engineers' motivation to perform at high levels.

Purpose of and Justification for this Study

It has been five years since GSFC has conducted a survey to assess how its employees are coping with the current budgetary and accounting practices. My study is coming at a significant time of great change. I also focus on a very specific and significant segment of the workforce. Several high level executives whom I have interviewed expressed concern about how the culture was shifting and its impact on employees. According to Krista Paquin, former Associate Center Director at NASA Goddard, my study in this area is "timely, and would be a good replacement for the cultural survey" (Paquin, personal communication, May 15, 2006). Lina Savkar, former Director of the Office of Human Resources is concerned about how to implement this new culture of fiscal accountability without breaking the spirit of creativity and innovation that made the Center great (Savkar, personal communication, May 17, 2006). Orlando Figueroa, current Director of the Applied Engineering and Technology Directorate is concerned about maintaining diversity among the engineering staff in his organization during this period of culture change (Orlando, personal communication, May 17, 2006). Each of these executives has expressed concern about the impact and tension that externally driven cultural change would have on the workforce's ability to perform at high levels.

This study is intended to determine how supervisor/manager behaviors, internal factors, external factors (e.g., *full cost* accounting) and demographic factors have affected NASA's Goddard Space Flight Center's 1,050 engineers' level of motivation. The focus of this study is on engineers as a professional class of workers. A distinguishing characteristic of a professional is having knowledge and skills beyond what is required to perform a specific task, such as a crane operator or bricklayer. Professionals generally are able to apply knowledge, skills, and

fundamental principles within their professional domains. They are highly motivated internally, and place significant value on the quality of work that they do, and have a sense of work efficacy. In particular, we know that NASA engineers recognize they are part of a larger mission and have a high degree of loyalty to NASA. A review of the literature in chapter 2 of this study will explore engineering as a profession in more detail.

Personal Connection to the Study

October 4, 1957 marks the beginning of the Space Race with the launch of the very first satellite, the Sputnik by the Soviet Union. That date also marks the day that I was born and 34 years later, in 1991, I began working at NASA. After having worked the first ten years of my career in the defense industry, I felt compelled to use my engineering skills for the benefit of mankind rather than designing weapons of war, and NASA seemed to be an exciting place to work. I was in grade school during the Gemini and Apollo eras and watched with great excitement as Neil Armstrong first stepped on the moon. I had the opportunity to work in several different areas at NASA and on several different projects. I was able to travel to all ten of the NASA field centers on several occasions. I learned that each center had a unique culture and unique capabilities. These experiences gave me a broad perspective of the Agency. My work at NASA Headquarters in Washington, DC also enabled me to see the *big picture* of all of NASA's programs and it helped me gain an appreciation for the politics that drove many NASA policies.

In 1996, I took a position at GSFC working on the Meteorological Satellite program in which I worked with other agencies such as the National Oceanic and Atmospheric Administration (NOAA), as well as the Department of Defense. In 1998, I applied for a supervisory position and was selected as an Associate Branch Head of an Engineering Branch at GSFC. My role as a supervisor gave me an opportunity to learn and develop my leadership skills. I also developed an interest in mentoring, giving feedback to my subordinates, and helping them

advance their careers. I discovered that this behavior was not the norm for supervisors at Goddard. I also had the opportunity to be exposed to senior executives and was privy to many larger issues at GSFC. This led to my involvement in several different committees and working groups, including the Cultural Survey Assessment Working Group, Engineer Promotion Criteria Working Group, African American Managers Council (which I established), and the Applied Engineering and Technology Directorate (AETD) Diversity Council, which I organized and chaired. I also worked on major change projects, and developed and helped implement an accelerated leadership development program.

In 2002, GSFC's culture shifted--senior managers in AETD wanted first line supervisors to focus more on the technical work, resulting in a minimal emphasis on leading people, the element of supervision where I was highly skilled and that I valued the most. I decided to take a temporary assignment in the Office of Human Resources (OHR), Leadership and Organization Change Office. This coincided with the start of my journey at Antioch University in the PhD program in Leadership and Change. My experience in OHR helped me get clarity around my passion for human development and organizational development. At the end of the temporary assignment, I was unable to get a permanent job in OHR because my engineering salary exceeded any positions that they could offer me, and so went back to the engineering directorate after 15 months in OHR. Typically, administrative organizations had a lower pay scale than the technical organizations, even with recent attempts to close the gap. It should also be noted that the administrative organizations had a majority of female employees, whereas the technical workforce was predominantly male. On my return to AETD, I was assigned to work in the Integrated Mission Design Center (IMDC) as a Team Leader. This change turned into a great opportunity. The IMDC is a rapid engineering design center that uses a collaborative engineering process, in that discipline engineers work real time with scientists to develop conceptual

spacecraft designs to meet the science objectives. The work was very exciting because this design activity (referred to as a *study*) is completed in one week. Therefore, it required the *team lead* to have very good people skills, with a demonstrated competence in facilitating technical interchanges and knowledge of human systems and communication processes. In the role of *team lead*, I had to motivate the discipline engineers who were not permanent staff, but were on loan for the study week. I was also required to manage the customer's (i.e., scientist's) expectations with regard to the final product that we delivered at the end of the week. The IMDC provided the perfect blend of spacecraft systems engineering and human systems engineering. My past 15 years of experience at NASA have placed me in a unique position to conduct research on the factors that affect the motivation of the 1,000 engineers working in NASA Goddard's AETD.

Research Questions

The purpose of this study is to identify critical factors underlying the work motivation of NASA engineers. Specific research questions are:

1. What is the relative influence of demographic factors on the motivation of NASA engineers?
2. What specifically, is the influence of supervisor behaviors on motivation?
3. How do intrinsic and extrinsic factors influence motivation levels?

Question one considers demographic factors such as race, gender, age, and years of experience. This work will pay particular attention and be sensitive to how different groups may be motivated differently, for example, whether African American engineers are motivated differently than non-African American engineers. Also, what effect do gender, age, and years of experience have on motivation?

Question two addresses the effect of supervisor behaviors on the level of motivation of the engineers. What behaviors increase motivation and what behaviors decrease motivation?

Question three considers intrinsic and extrinsic factors. I previously presented evidence that NASA Goddard engineers are highly motivated (results of 1997, 1999, and 2002 culture surveys). The culture surveys indicate the importance of intrinsic factors such as stimulating and challenging work, personal pride in working at NASA Goddard, doing work that is personally rewarding, the desire to perform at higher levels, and the feeling that their work contributes to the Center's success (GSFC, 1999; GSFC, 2003). Extrinsic factors are those pertaining to things external to the individual in the organization such as policies, processes, organizational structure, facilities, pay, promotions, benefits, awards, and recognition.

Description of Terms--Matrixed Employees

Matrix management began in the 1960's, primarily within the aerospace industry, although earlier versions of this management structure existed in other organizations. The government contract selection process required that a project-oriented system be directly linked to top-management. In order to meet this requirement, aerospace firms established a set of horizontal project groups over their traditional vertical functional organizations. This created an organization in which many employees worked both under a department head and a project manager of an interdisciplinary project team. When depicted on paper, this crossing of organizational lines is easily represented by a grid or a matrix--hence, the term *Matrix Organization* was created (Kuprenas, 2003).

According to Larson and Gobeli (as referenced by Kuprenas, 2003), there are three types of matrix organizations--functional, balanced, and project. Each of these types is based on how much authority the project manager has over the matrixed employee. In the functional matrix organization, the functional manager has control over the matrixed employees and the project manager is only responsible for overseeing the project across functional areas. In the balanced matrix organization, as the term would imply, the functional manager and project manager share

equal responsibility for project resources. Under the project matrix structure, the functional manager's authority is the smallest, with functional managers only assigning resources for the project and providing technical consultation on an as-needed basis. Project managers are assigned to oversee the project and are responsible for the completion of the project. NASA Goddard operates under a project matrix structure where the functional manager, referred to at NASA as the administrative supervisor, assigns engineers to support various projects under the authority of a project manager or technical manager. For this study, I will use the terms *manager* and *supervisor* interchangeably.

My basic assumption is that all of the management positions within AETD--branch managers, division managers, project managers, and directorate managers--have math, science, or engineering backgrounds. I have not identified any case within the AETD where a non-technical manager supervises engineers. The managers that I will refer to as administrative supervisors are responsible for hiring, firing, performance evaluation, training, career development, approving vacation, sick leave, promotions, and job placement. The technical managers that directly supervise the technical work of the engineering staff on a day-to-day basis are project managers or project team leads. They assign specific tasks to the engineers, and monitor their work, and evaluate their products (i.e., designs, fabricated hardware, software, test procedures, etc). The administrative supervisors communicate with the project managers to get input for conducting performance evaluations. Feedback is solicited on how well the engineer is performing the assigned task and if any deficiency exists that impacts the project success. This study will consider the behaviors from both sets of managers.

Organization to be Studied

The focal group under study is the population of approximately 1,050 engineers that currently work in the AETD at the NASA Goddard Space Flight Center. AETD provides

engineering services through each of its divisions representing several engineering disciplines (e.g, mechanical, electrical, and aerospace, software, systems, and other specialties).

Figure 1.1 AETD organizational chart (2008).

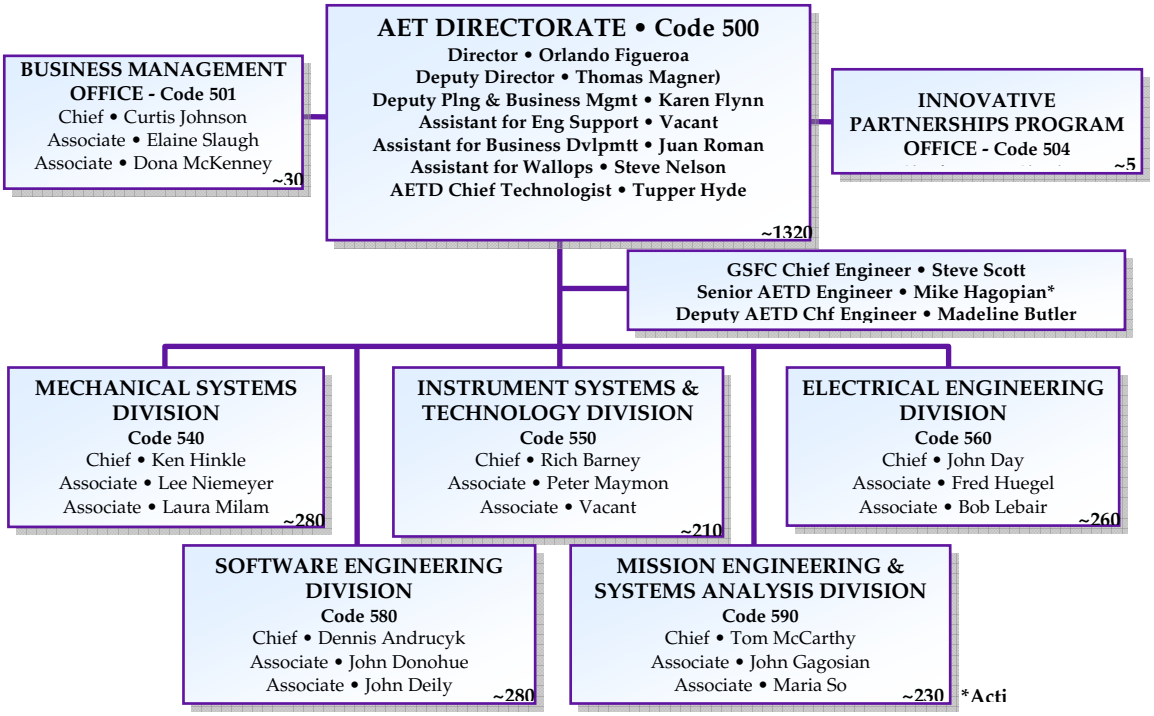


Figure 1.1 Provided courtesy of Nancy Patton, Administrative Officer, AETD.

This engineering expertise is provided to the flight programs and projects using a matrix organizational model. Work comes to Goddard through the annual NASA budget that funds the flight projects. These flight projects are either directed missions or competitively awarded missions. Goddard is the primary Center for Earth and Space Science Research and must compete with other NASA Centers, universities, aerospace companies, and other federal agencies for funding. Each flight project annually submits requests for engineering support to AETD via a workforce planning exercise within NASA Goddard. The flight project requests a

specific amount of discipline engineering expertise in the form of Full Time Equivalents (FTEs)[4]. These engineers work for the flight project from the initial mission concept to end of mission life when science data collection terminates. The average project lasts five to ten years. There are exceptions. The Hubble Space Telescope has now been in service since 1990 and is planned to remain in service until 2020 when it will be de-orbited and burned up in the atmosphere. Flight project work is the life blood of NASA Goddard and engineers compete for jobs on flight projects. The most skilled and competent engineering staff with a proven track record of outstanding performance are selected to work on the highly visible and big budget projects. Will engineers' motivation be affected if they move from a highly visible, big budget project to a less visible small project? This research will consider GSFC's matrix type structure as one of the external factors that may influence engineer's motivation.

Summary of Chapters

In this chapter, I have presented the purpose and intent of this dissertation, the problem to be addressed, the questions to be explored, and the relevance of the research. I have also situated myself as a researcher.

Chapter 2 presents a critical analysis of previous work on engineer motivation. It investigates how, historically, the motivation of engineers has previously been studied, summarizes relevant motivation theories specific to engineer motivation, investigates the relationship between leadership and motivation of engineers, and cites the shortcomings and gaps of earlier work.

Chapter 3 explores the methodological approach that this work will employ. The dissertation will be a quantitative study using a multivariate regression analysis approach. Motivation is used as the response variable, and demographic, supervisor behavior, and

[4] Full Time Equivalent (FTE) is one year of work of one person equal to 2044 hours fully loaded, including holidays, sick days and vacation time.

intrinsic/extrinsic factors are used as predictors. This chapter will also cite limitations and address validity and reliability of the methodology.

Chapter 4 includes comments from the pilot survey.

Chapter 5 reveals the results of the study and analysis of the data.

Finally, chapter 6 summarizes the results, draws conclusions, and discusses implications for NASA Goddard.

Chapter II: Review of the Literature

This literature review focuses on three areas, the definition and theory of work motivation, the relationship between leadership and engineers' motivation, and the scholarly work that has been done on engineer motivation over the past several decades.

What is Motivation?

According to Spector (2006), "motivation is an internal state that induces a person to engage in particular behaviors" (p. 194). Many researchers agree that there is more than one type of motivational behavior. Vroom and Deci (1970) argue that there are two aspects to work motivation; the first refers to the ability or skill of the individual to perform the job and the second refers to his motivation to use this ability or skill in the actual performance of the job. In other words, one may be skilled at doing a particular job but may not be motivated to use that skill to perform the job well. Vroom (1964) also suggests that motivation has a voluntary behavioral aspect and an involuntary behavioral element (i.e., conscious and unconscious behavioral elements). Wlodkowski (1999) suggests that between two people with identical ability, if given equal opportunity and conditions to achieve, the motivated person will surpass the unmotivated person in performance and outcome. Katz (2004) argues that motivation does not guarantee high performance and success; however, its absence seems to result in long-term problems. Katz (2004) further argues that highly motivated people and teams push themselves to overachieve, stretching their thinking and working arduously to accomplish considerably more than brighter and even more technically competent peers. What is suggested is that motivation operates independent of one's knowledge, skills, and abilities in determining level of performance. Herzberg (1971) suggests another perspective, "humans have two sets of needs: the need as an animal to avoid pain and the need as a human to grow psychologically" (p. 71). Vroom (1964) similarly suggests that motivation has its origins in hedonistic principles in that

behavior is directed toward pleasure and away from pain. This would suggest that people are motivated to follow the path of least resistance. In contrast, Spector (2006) argues that an aspect of motivation is the direction, intensity, and persistence of behavior over time. This appears to contrast the hedonistic thought, in that people often endure moderate levels of pain or discomfort while performing a task or pursuing a goal (e.g., athletes competing with injures). Spector (2006) further suggests that motivation arises from a person's wants, needs, or desires. Spector follows Maslow's (1968) reasoning that there are several subjective characteristics of motivation, based on "need, conscious or unconscious yearning and desire, feeling of lack or deficiency, or palatability" (p. 22). Ryan, (as cited by Locke and Latham, 2002), suggests that human behavior is most influenced by conscious purposes, plans, and intentions. The goal-setting theory of motivation relates to the premise that conscious goals affect action. A goal is the aim of an action within a specified time limit (Locke & Latham, 2002). The general research suggests that work motivation is either a need or desire that is goal driven resulting in some action and a conscious and unconscious force that has a significant influence on an individual's job performance to the point that a highly motivated person could outperform a more technically competent individual. So what is that internal force that drives individuals to perform above and beyond what has been asked of them?

There is overwhelming evidence that the potential for intrinsic motivation is present in all of us. According to Deci (1972), "a person is intrinsically motivated if he performs an activity for no apparent reward except the activity itself and extrinsic motivation refers to the performance of an activity because it leads to external rewards" (p. 113). Robert White (as referenced by Deci, 1975) suggests that intrinsically motivated behaviors are ones which a person engages in so that he may feel competent and self-determining relative to his environment. Csikszentmihalyi (1999) introduces the concept of *flow* or autotelic experiences in

which a person can become engrossed in an activity even though there may not be an external consequence. *Autotelic* comes from two Greek roots, auto (self) and telos (goal). According to Csikszentmihalyi (1997), the primary goal of an autotelic activity is experience for its own sake, whereas an *exotelic* activity is motivated by an outside goal. Csikszentmihalyi (1996) and Csikszentmihalyi (1999) further suggests that experiencing flow regularly is essential in achieving happiness. There is also evidence that extrinsic motivation has a negative affect on intrinsic motivation. Deci (1972), Harackiewcz, Sansone, and Manderlink (1985), and Herpen, Praag, and Cools (2005) all suggest that extrinsic rewards, such as money, diminish intrinsic motivation by *crowding out* the internal driver.

Deci (1975) cites his pioneering work in which he measured the effects of external rewards on intrinsic motivation. His cognitive evaluation theory has three propositions:

> Proposition one: One process by which intrinsic motivation can be affected is a change in perceived locus of causality (reason for a particular behavior) from internal to external. This will cause a decrease in intrinsic motivation, and will occur, under certain circumstances, when someone receives extrinsic rewards for engaging in intrinsically motivated activities (Deci, 1975, p.139).
>
> Proposition two: The second process by which intrinsic motivation can be affected is a change in feelings of competence and self-determination. If a person's feelings of competence and self-determination are enhanced, his intrinsic motivation will increase. If his feelings of competence and self-determination are diminished, his intrinsic motivations will decrease (Deci, 1975, p.141).
>
> Proposition three: Every reward (including feedback) has two aspects, a controlling aspect and an informational aspect which provides the recipient with information about their competence and self-determination. The relative salience of the two aspects determines which process will be operative. If the controlling aspect is more salient, it will initiate a change in perceived locus of causality process. If the informational aspect is more salient, the change in feelings of competence and self-determination process will be initiated (Deci, 1975, pp.139-142).

In summary, key elements of motivation are needs, goals, and rewards. These elements have both an intrinsic aspect, as well as an extrinsic aspect that both have an effect on each other. We intrinsically have a need to feel competent, self-determined, and self-actualized in the pursuit of a particular goal; the reward is achieving that feeling through some activity. From an extrinsic

perspective, we have a need to pursue a goal in order to obtain an extrinsic reward such as money. There is also compelling research that suggests that extrinsic rewards diminish intrinsic motivation by shifting the individual's reason for engaging in the activity from internally driven to externally driven (Deci, 1975).

The setting for this study is the workplace. In the next section, I will explore motivation as it relates to the workplace.

Motivation in the Workplace

Work motivation, at its core, is based on relationships--the relationship with the individual and the task at hand, the relationship between the individual and that person's peers, and the relationship between the employee and their supervisor. Maslow (1998)[5] discusses the relationship between an individual and the job or task at hand. He suggests that the perfect situation is "when people love their work and are absorbed in it and enjoy it so much that they can hardly think of themselves apart from it" (p. 153). When considering motivation as it relates to an employee with his/her peers, Maslow (1998) suggests a *Gestalt motivation* in which the whole is greater than the parts, for example, the organizational mission or goal is greater than the individuals that make up the organization. This implies that motivation extends beyond personal wants and needs as Herzberg (1971), Spector (1997), Vroom (1964), and Deci (1975) suggest. NASA fits this model in that our mission to explore serves as a galvanizing element that intrinsically motivates the workforce to work together to achieve a goal greater than any one individual. The basic premise of this work is that NASA engineers are motivated differently from other professionals such as scientists, physicians, lawyers, accountants, and business executives. In my experience as a NASA engineer, I have found that scientists create new knowledge and engineers apply scientific theory; scientists tend to be more loyal to their

[5] This is a republication of Maslow's 1965 work entitled, "Eupsychian Management."

scientific profession and engineers tend to be more organizationally loyal. However, both engineers and scientists are innovative and make use of cutting edge technology in their work.

Maslow (1970) argues that needs, which he refers to as the physiological drives, usually serve as the starting point for motivation theory. Those basic physiological needs, for food, water, shelter, and comfortable temperature, serve as the first level of motivators for humans. Maslow (1970) developed the hierarchy of needs model that illustrates the progression from basic physiological needs to the self-actualizing needs and the motivations associated with those needs. Maslow's theory breaks down the needs in a pyramid of five basic need levels. They are physiological needs, safety needs, belongingness and love needs, esteem needs, and self-actualization needs. Maslow states that, in order for a higher level need to be satisfied, the preceding need must be met. In the work environment it is reasonable to conclude that all of these needs come in to play at some level in affecting employees' motivation.

Physiological needs appear to be extrinsic in nature relating to comfortable physical environment. Examples include: office or lab space, temperature, lighting, noise level, and accessibility to food and water such as cafeteria, restaurants, lunch break rooms, and vending machines. Safety needs in the workplace include both physical security, that is, the level of physical harm associated with the job (e.g., coal minor vs. office worker), and also emotional safety, which is the ability to surface problems and issues to management without the fear of retribution. Maslow (1970) asserts that the self-esteem need consists of "the desire for strength, achievement, adequacy, mastery, competence, confidence, independence, and freedom, as well as a desire for reputation and prestige" (p. 21). These self-esteem needs match many of the same motivation needs of individuals in the work environment. Maslow (1970) argues that self-actualizing needs such as creativity emphasizes the personality--qualities like boldness, courage, freedom, spontaneity, perspicuity, integration, and self-acceptance--rather than one's

achievements. Creativity has internally driven components related to a person's character rather than externally driven goals. Burns (1978) agrees that Maslow's concept of self-actualization represents the motivation to become those qualities that are a potential growth of self. This also aligns with Deci's (1975) argument that a person engages in an activity to feel a sense of competence and self-determination.

What is the nature of the relationship between supervisors and engineers that elicits a high level of motivation and performance from NASA Engineers? I will address this question from three aspects: first, the broad leadership literature about employee motivation and performance; second, the nature of the engineering profession with regard to what motivates engineers; and third, additional questions that arise about the relationship between leadership and the motivation and performance of engineers.

Leadership and Motivation

What is the relationship between leadership and motivation? What role do leaders need to play if there is an intrinsic motivation characteristic in followers?

Burns (1978) states, "the leader is more skillful in evaluating followers' motives, anticipating their responses to an initiative, and estimating their power bases, than the reverse" (p. 18). There is an expectation that leaders will take the major part in maintaining and effectuating the relationship with followers, and will have the major role in ultimately carrying out their combined purpose. Another important point is that leaders should concern themselves with followers' wants, needs, and other motivations, as well as their own needs. The relationship between leader and follower centers on needs being met by both parties and the motivating drivers to get those needs met. Burns (1978) also suggests that "the essential strategy of leadership in mobilizing power is to recognize the array of motives and goals in potential followers, to appeal to those motives by words and action, and to strengthen those motives and

goals in order to increase power of leadership, thereby changing the environment within which both followers and leaders act" (p. 40). This suggests that the source of power for leaders lies within the motives and needs of the followers. According to Kotter (1999) leadership seeks to motivate, inspire, and energize people, not by pushing them in the right direction as control mechanisms do, but, by satisfying basic human needs for achievement--a sense of belonging, recognition, self-esteem, a feeling of control over one's life, and the ability to live up to one's ideals.

Good leaders motivate people in a variety of ways. Yukl (1998) suggests that charismatic leaders increase individual and collective self-efficacy of followers. Individual self-efficacy is the belief that one is competent and capable of attaining difficult task objectives. People with high self-efficacy are willing to expend more effort and persist longer in overcoming obstacles to the attainment of task objectives. Bandura (as referenced by Yukl, 1998) suggests that *collective self-efficacy* is the perception held by group members that they can accomplish exceptional feats by working together. When collective self-efficacy is high, people are more willing to cooperate with members of their group in joint efforts to carry out their joint mission. A charismatic leader focuses on enhancing follower self-esteem and self-efficacy by communicating high-performance expectations and expressing confidence that followers can attain them. How then, can self-actualization, self-efficacy, self-esteem, self-acceptance, self-determination, and so on, be manifested in a large traditional bureaucratic organization where individual achievement is downplayed and organizational achievement is more the focus?

Burns (1978) argues that

> . . . at the root of bureaucracy lies some kind of struggle for power and prestige. The struggle pervades the bureaucracy because it engages persons who tap one another's motivational and need bases and who have various power resources (withdrawal of services, denial of esteem to others, widening the area of conflict by such devices as giving 'confidential stories' to the press, appeals up the line to superiors or unions or professional associations) that they can employ or mobilize in this process. (p. 299)

The consequence of this is that persons who experience a loss from the power struggle lose motivation because their needs are not met. According to Greenleaf (1996), “Motivation ceases to be what is done to people. Motivation becomes what people generate for themselves when they experience growth” (p. 121). Growth in the job is an example of an intrinsic motivating factor. Bennis (2000), relating motivation to the demise of the bureaucratic organization, states that the “organic-adaptive structure” increases motivation and thereby effectiveness, because it enhances satisfactions intrinsic to the task. (p. 101) There is a harmony between the educated individual’s need for tasks that are meaningful, satisfactory, and creative, and a flexible organizational structure.

Bureaucratic organizations use a variety of incentives to motivate employees. Kantor (1997) suggests that more and more businesses are doing away with the old bureaucratic incentives and using entrepreneurial opportunity to attract the best talent. This forces managers and supervisors to exercise more leadership, as they perceive their bureaucratic power slipping away. As employees become more empowered, managers must shift their beliefs about power to create an environment that sustains motivation. Kantor (1997) also states that traditional motivation tools are no longer available to managers in ever- changing organizations. In certain types of organizations, extrinsic tools such as control of information, control of promotion and pay, control of employees’ work assignments, being the expert, even lines of direct reporting are blurred, as in matrix organizations. Kantor (1997) suggests new tools that are more intrinsically focused, including

1. Mission--helping people believe in the importance of their work, giving people a sense of purpose and pride in their work. Pride is often a better motivator than the traditional corporate career ladder or promotion-based reward system.
2. Agenda control--more and more professionals are passing up jobs with glamour and prestige in favor of jobs that give them greater control over their own activities and direction. Subordinates have this opportunity when they are given flexibility to work on pet projects, when results are emphasized instead of procedures, when work, and decision making about how to do the work, is delegated to them.

3. Share of value creation--incentives are based on performance. All employees have an opportunity to share in the kinds of rewards that are abundant and free--namely awards and recognition.
4. Learning--the chance to learn new skills or apply them in new arenas is an important motivator in an ever- changing environment because it is oriented toward securing the future. In the world of high technology, where people understand uncertainty, the attractiveness of any organization often lies in its ability to provide learning and experience. Access to training, mentors, and challenging projects is more important than pay or benefits.
5. Reputation--a key resource in professional careers, and the chance to enhance it can be an outstanding motivator. The professional's reliance on reputation stands in marked contrast to the bureaucrat's anonymity. Managers can enhance reputation--and improve motivation--by creating stars, by providing abundant public recognition and visible awards, by crediting the authors of innovation, by publicizing people outside their own departments, and by plugging people into organizational and professional networks. (pp. 51-55)

Along with the above tools for creating a more intrinsically motivating organizational environment, Landy and Guion (as referenced by Arvey & Neel, 1974; 1976) identified seven motivational dimensions or job performance measures for professionals that are more intrinsically focused:

1. Professional identification--a desire to continue self-development within the profession, as opposed to seeing it as an entry occupation.
2. Job curiosity--consistency in exploring ramifications of assigned work, as opposed to confining one's interest to the assigned task itself.
3. Team attitude--tendency to recognize the expertise of others potentially in conflict with one's own expertise; ability to evaluate such conflicts in terms of overall goals, as opposed to being self-centered and unable to evaluate and negotiate differences intelligently.
4. Task concentration--tendency to work for long periods of time without awareness of things other than the task at hand, as opposed to easy distractibility.
5. Independence/self-starter--tendency to do what needs to be done without being told, as opposed to waiting for instructions before beginning even routine tasks.
6. Persistence--tendency to keep working in the face of adversity, as opposed to giving up too easily.
7. Organizational identification--a broad concern for and acceptance of company goals, as opposed to a kind of organizational myopia. (p. 115)

Shifting to using the tools and performance measures mentioned above represents a significant cultural change for traditional bureaucratic organizations.

Schein (1999) does not specifically address motivation, but he does consider organizational culture with regard to rewards and status in organizations, which are closely linked to motivation in employees. Schein (1999) argues that the organizational culture determines which types of rewards are most valued: "the most obvious form of reward is pay increases and promotion up the ladder" (p. 47). Schein (1999) further suggests

> In some organizations, and for some employees, promotions and monetary rewards such as salary, bonus, stock options, and profit sharing are the primary rewards and sources of status. In other organizations it is titles that matter, or the number of subordinates who report to you. Still in other organizations, and for some other employees, (e.g., engineers and scientists in the R&D function), the size of their project, the project budget, the degree of autonomy with regard to working hours, the visibility they have in the organization, the degree to which senior management consults them about strategic issues, their professional status outside the organization, all these things may be more meaningful as rewards and status symbols than pay and benefits. (pp. 46-47)

Both Schein (1999) and Kantor (1997) acknowledge that classical bureaucratic motivational incentives are being replaced with incentives that are based on self-actualization. This raises a question--are organizational incentives enough to motivate employees?

Wheatley (1994) argues that in current motivation theory, attention is shifting from the enticement of external rewards to the intrinsic motivators that spring from the work itself. . . We are refocusing on the deep longings we have for community, meaning, dignity, and love in our organizational lives.

Goleman (1998) discusses motivation in the context of training, development, and learning, offering that people learn to the degree that they are motivated, "motivation influences the entire learning process" (p. 265). Boyatzis (as referenced by Goleman, 1998) argues that people have to be grabbed by their values, goals, and dreams of what is possible for them. If organizations focus up front on people's values and visions, and what they want to do with their lives, then people see themselves as using training opportunities for their own development--not just the company's. Goleman (1998) further observes that there are specific windows of

opportunity for development--moments when we are most motivated to upgrade our capabilities or what we know as the *disorienting dilemmas* in life and that these *moments* come at predictable points in a career. Goleman (1998) states that

> . . .added responsibility, like a promotion, can make a weakness in emotional intelligence glaringly apparent. Life crises, like trouble at home, career doubts, or a 'midlife crisis' about direction, can offer a fruitful motivation to change. Job troubles, like interpersonal difficulties, disappointment with an assignment, or feeling unchallenged, can motivate efforts to boost competencies. (p. 265)

Segal (1997) references Jung's theory that people have an inherent drive to grow and develop. The "Self" is the archetype that drives this search in the form of a process of differentiation and integration (p. 69). To illustrate this, Segal (1997) compares the American motivational archetype to the Japanese archetype. For Americans, the emphasis is on failure-breeding success. The Japanese emphasize that failure does not breed success. Americans, given the right support, mentoring and coaching have the ability to summon the energy to be creative. This energy however dissipates with success. The Japanese are more easily motivated to follow Deming's model, "do it right the first time." Japanese society encourages people to not be bored with success but to continuously refine and improve (p. 71). Culture has a major influence on motivation and performance. Participation, belongingness, and a sense of community, as Wheatley (1994) and Kantor (1997) suggest, are also key factors of motivation and performance. Kurt Lewin's work with Harwood Manufacturing (as referenced by Segal, 1997) argues that supervisors who received training in human relations and leadership skills were more effective in the workplace than those with purely technical skills.

The broad leadership literature reveals that employee motivation should be studied at three levels: employees themselves, their supervisors, and the organization. Ideally, all three of these must be present to facilitate and support a sense of self-actualization. This is done by tapping into the needs of the employee while ensuring that the needs of the organization and

supervisor are met as well. Generally, the literature suggests that organizations, particularly bureaucratic organizations, need to shift from the traditional control and authoritarian structure toward a more inclusive, self-actualizing organizational environment. The later type of organization taps into a professional's need to experience self-efficacy and feelings of competence which tends to increase their intrinsic motivation.

The Engineering Profession

This section will examine the nature of the engineering profession and its unique qualities, as well as the professionalism of engineering work. This section will also explore the literature on the motivation and job performance of engineers.

The oath below is taken from the certificate of induction into the Order of the Engineer:

> Obligation of an Engineer: I am an Engineer. In my profession I take deep pride. To it I owe solemn obligations. Since the Stone Age, human progress has been spurred by the engineering genius. Engineers have made usable Nature's vast resources of material and energy for Mankind's benefit. Engineers have vitalized and turned to practical use the principles of science and the means of technology. Were it not for this heritage of accumulated experiences, my efforts would be feeble.
>
> As an Engineer, I pledge to practice integrity and fair dealing, tolerance and respect; and to uphold devotion to the standards and the dignity of my profession, conscious always that my skill carries with it the obligations to serve humanity by making the best use of Earth's precious wealth.
>
> As an Engineer, in humility and with the need for Divine Guidance, I shall participate in none but honest enterprises. When needed, my skill and knowledge shall be given without reservation for the public good. In the performance of my duty and in fidelity to my profession, I shall give the utmost.[6]

This oath embodies the virtues of the engineering profession, emphasizing utilizing one's technical skills for the betterment of mankind, and practicing integrity, fair dealing, tolerance, and respect. A distinguishing characteristic of a professional is having knowledge and skill beyond what is required to perform a specific task, such as a crane operator or bricklayer. A professional generally is able to apply knowledge, skills, and fundamental principles within the professional domain. A professional uses an ever-expanding body of knowledge in practicing the

[6] Copyright c 1981, The Order of the Engineer, Inc.

profession. A tradesperson or craftsperson operates in a more finite domain, in that skill is only necessary to accomplish the specific activity, such as bricklaying. A brick layer does not need to know the chemical processes that take place when concrete hardens, whereas a civil engineer, or materials engineer must understand this in order to continuously improve the bonding nature of concrete so that faster setting, harder, or longer lasting concretes can be developed. For an engineer, being professional is the unique aspect of utilizing science and technology to best serve humankind. Another important concept of the engineering profession is that of performing a service for people. According to Beakley and Leach (1972), "almost all engineering is performed to fill a need in some phase of our society" (p. 110). Some examples of this include developing safer and environmentally friendly automobiles, improving highway systems, or developing new, or more efficient, automated manufacturing methods to increase product quality at a reduced cost. At NASA, it is designing, building, and launching spacecraft with instruments that gather data to answer fundamental questions about our universe, solar system, and planet Earth. One distinguishing aspect of any profession is the existence of professional standards associated with that profession. The engineering profession, like many other professions, has two types of standards. The first type is a standard of ethical conduct as illustrated by the Order of the Engineer Oath. These ethical codes emphasize integrity, fair dealing, tolerance, and respect. Similar words are found in other professions such as in the Hippocratic Oath for Medical Doctors, the Socratic Oath for Attorneys, and the professional societies that have been established for these professions. The other standard is one of competency certification. For engineers, it is the Professional Engineer (PE) exam. Other professional exams include the CPA Exam, Bar Exam, and Medical Boards. The Society of Professional Engineers governing board that gives legal certification to engineers administers the PE exam. The PE exam is not required to work in industry or government--it is primarily required for legal registration to meet state

registration laws for engineering contracting in public works. The PE exam is required for engineers who are in private practice and provide services such as building and road construction, transportation systems, water, gas, and electric utilities. The vast majority of engineers is not in private practice, but works for either government or commercial corporations and, thus, is not required to obtain professional certification.

Today, the engineering profession has been subsumed into the corporate culture, and engineers see themselves from an organizational affiliation rather than a professional engineer orientation. Kerr (as cited by Bailyn & Lynch, 1983) argues that engineering, even though based on technical expertise, is not a profession. Bailyn and Lynch (1983), Badawy (1988), and Keller (1997) further corroborate that practitioners have been shown, as a group, to subscribe more to organizational than to professional values. Thus, the organization's code of ethics for professionalism and behavior become the prevailing guidelines. Another interesting observation by Bailyn and Lynch (1983), Al-Faleh (1991), and Capretz (2003) is that society stereotypes the engineering profession as being very different from engineers' self-definition of their profession. Engineering societies, engineering associations and engineering fraternities all serve to define and professionalize engineering. Al-Faleh (1991) observed that the engineers identify themselves with their profession through their professional associations. Al-Faleh (1991) further points out that this achieved group identity is a technical group separated from their employing organizational group. Another trend of growing importance is that engineers and scientists are viewed as *knowledge workers*[7] or technical resources where their organizations provide or sell the professional knowledge of its people (Badawy, 1988; Keller, 1997). It is also worth noting

[7] *Knowledge workers* refer to highly- *skilled types of labor where education, sophisticated training, and sharp talents are needed to perform these highly specialized activities in organizations such as R&D laboratories, engineering firms, and advertising agencies.*

that often research studies on job performance of scientists and engineers tend to combine engineers and scientists into one category.

Allen (1977) states

> The social science literature is replete with studies of "scientists," who upon closer examination turn out to be engineers. Worse still, in many studies the populations are mixed, and no attempt is made to distinguish between the subsets.
> Many social scientists will view the two groups as essentially the same and feel no need to distinguish between them. This sort of error has led to an unbelievable amount of confusion over the nature of the populations that have been studied and over the applicability of research results to specific real-life situations. A common practice is to use the term "scientist" throughout a presentation, preceded by a disclaimer to the effect that "for ease of presentation the term scientist will be assumed to include both engineers and scientists." This approach totally neglects the vast differences between the two professions. (p.307)

McCall (as referenced by Day, 2003) describes how scientists are different professionally from engineers (see Table 2.1).

Table 2.1

Differences in Vocational Interests between Scientists and Engineers -

Scientists	Engineers
Investigative type	Realistic Type
Prefer symbolic, creative investigation	Prefer to manipulate objects
Value science, scholarship in problem solving	Solve problems w/realistic competence
Averse to persuasive competence, social, repetitive activities	Avoid activities of social occupations
Deficient in persuasive competence	Deficient in social competencies
Avoid enterprising occupations	Recognize their own low human relations skills
See themselves lacking in leadership ability	

Note: From McCall (1981, adapted from Holland (1973) and Campbell (1974).

Charlie Pellerin, a former NASA Chief Scientist has been quoted as saying, “Scientists like surprises and engineers hate surprises” (Pellerin, personal communication, October 10, 2005). At NASA Goddard, engineers and scientists often work closely together on project teams. I have observed that in the Integrated Mission Design Center (IMDC) at NASA Goddard, where engineers and scientists work in collaboration, scientists tend to be more comfortable working with loose mission requirements where mission parameters such as launch date, observation timelines, amount of data collected are not clearly defined. The engineers in the IMDC are very uncomfortable when mission requirements are not clearly defined and concretely determined. When asked to give their best guess or use their engineering judgment, many engineers exhibit great discomfort. They prefer to be given a set of requirements and then be left alone to develop their engineering designs and architectures. This study will be distinguished from previous work by specifically focusing on engineers as a unique professional group.

Is there a link between how engineers are treated and viewed as a professional group and their level of motivation to perform at high levels? The next section examines the literature on what motivates engineers and how the way they are treated professionally influences their level of motivation and performance.

Motivation of Engineers as a Professional Group

Significant empirical work through the years has investigated motivation as it relates to work performance. Much of that work has branched off into many directions. There have been numerous studies that focused on job characteristics associated with motivation specific to engineers (Andrews & Farris, 1972; Badawy, 1988; (Helphingstine, Head, & Sorensen, 1981), and Kellar (1997). Other studies by Arvey and Neel (1974a, 1974b, 1976) and Kopelman (1977)

have focused on expectancy theory,[8] which was first applied in an industrial environment by Vroom (1964). For example, Kopelman (1977) used five measures:

> . . .promotion into management . . .promotion to next engineering grade . . .significant salary increases based on merit . . .more challenging work assignments . . .more freedom to carry out your own ideas and using one's originality and initiative. (pp. 274-275)

The first three measures were extrinsic and the latter two were intrinsic. Zenger and Lazzarini (2004) examined compensation incentives between small high technology firms versus large high technology firms in Silicon Valley, CA. They concluded that small firms are in a position to offer more aggressive incentive packages then large firms because of their size and flexibility and, as a result, the smaller firms got higher performance and innovation from their engineers.

Andrews and Farris (1972) studied time pressure effects on scientists and engineers. The results of their study indicated that the productivity of scientists and engineers was positively related to deadlines and time pressures of technical teams. Andrews and Farris (1972) used these performance measures in their study:

1. Innovation--the extent the man's work had "increased knowledge in his field through lines of research or development which were useful and new."
2. Productiveness--the extent the man's work had "increased knowledge along established line of research or development or as extensions or refinements of previous lines."
3. Usefulness--the extent the man's work had been "useful or valuable in helping his Research & Development organizations carry out its responsibilities. (p. 188)

Badawy (1988) suggested that motivating factors for professionals in general tend to be achievement, recognition, work assignments, and professional administration, and, specifically for knowledge workers, including engineers: freedom of action, increasing responsibility, a high degree of autonomy, and control over their own activities. Hackman and Oldham (as referenced

[8] Expectancy theory: an individual's motivational force for a particular act is, in part, a function of the individual's expectations that performance will result in the attainment of particular job reward outcomes as well as the desirability or undesirability of these reward outcomes.

by Katz, 2004) suggest that “people are more motivated when they feel their jobs require them to use a wide variety of skills and abilities according to the framework [in Table 2.2]” (p. 5).

Table 2.2

A Framework for Work Motivation

Dimensions of Task Characteristics	Definitions
Skill variety	The degree to which the job requires the use of different skills, abilities, and talents.
Task identity	The degree to which the person feels a part of the whole job or project activity from beginning to end.
Task significance	The degree to which the job is considered important by, and has impact on, the lives of others.
Autonomy	The degree to which the job provides freedom, independence, and discretion in how the work is carried out.
Feedback	The degree to which the person is provided with clear and direct information about the effectiveness of the performance.

Note: From Katz (2004), adapted from Hackman and Oldham, 1980.

If we compare the performance measures that have been used for engineers with these motivating factors for professionals and knowledge workers, a pattern emerges. This pattern is also consistent with the theories of Maslow (1970), Vroom (1964), and particularly Herzberg, Mausner, and Snyderman (1959), who identified the Factors-Attitude-Effects (FAE)[9] complex within individuals. Herzberg et al. (1959) identified the motivators as achievement, recognition, work itself, responsibility, and advancement. Herzberg et al. (1959) identified the hygiene factors as company policy and administration, technical supervision, salary, interpersonal relations, working conditions, benefits, and job security. Herzberg's motivators are more intrinsically focused, whereas the hygiene factors are more extrinsically focused.

Maki (2001) and Maehr and McInerney (2004) recognize that, for more than half a century, motivation in the workplace has been studied and theorized. With all of this research on motivation in the workplace has a fundamental conclusion been drawn? Maehr and McInerney (2004) asked, "Is there a single motivational environment that can be constructed in most applied settings (e.g., schools, hospitals, businesses, government organizations) . . .?" (p. 83). Given the wide range of environments and diversity of the individuals that make up those environments, this is not an easy question to address. I believe that generalizations are possible within very narrow work environments and career fields, which serve as the basis for this work (focusing on the motivation and performance of engineers in technical organizations). The body of literature investigated on the motivation of engineers suggests that the significant factors or measures are professional or organizational identity and status, independence or autonomy, recognition and advancement or promotion, ability to be innovative or creative, and being part of something larger than themselves that helps humankind. Donald Pelz (as referenced by Katz, 2004) also

[9] The FAE complex consisted of: (1) factors that contributed to workers feeling either exceptionally good or exceptionally bad about the job, (2) attitudes that resulted from those factors, and (3) the effects of those attitudes (Herzberg et al., 1959, p. 11).

discovered that scientists and engineers were judged most effective when they devote their time across the range of activities within the research, development, and technical service continuum rather than concentrating in only one of these domains. Katz (2004) further suggests two other factors that significantly contribute to engineers' motivation: peer recognition of their technical accomplishments, and to work on projects that improve the quality of people's lives is the ultimate dream. NASA Goddard engineers get the opportunity to work on projects that will answer fundamental human questions such as: How did the universe begin? Or, how is our planet changing? Or, are we alone in the universe? The NASA mission serves as the gestalt that galvanizes and motivates the engineering workforce.

How do technical supervisors become aware of these factors and leverage them to motivate and elicit peak performance from their technical employees? The next section explores the impact that technical managers and engineering supervisors have on engineers' motivation and performance. This section will investigate the relationship between supervisor and employee and how it impacts motivation. It also examines the existence of bias in performance ratings conducted by engineering supervisors and how bias in performance ratings impacts performance and motivation.

Supervisor Impacts on Engineer Motivation

In many technical organizations, engineers who perform at high levels and have excelled in their area of expertise are often selected for management positions. A key element of a professional engineer is the level of autonomy that they have in performing tasks. They use their skills and abilities according to their individual style of working and level of competence in solving problems. Katz (2004) suggests that when professionals become managers, they soon discover that they must now count on the motivations and competencies of subordinates for getting the problems solved and for getting the work done. This career transition can be

problematic, particularly for some of the most technically proficient engineers who reluctantly find they have to be responsible for managing and supervising the work of subordinates who may not have their level of technical competence. It is even more problematic for non-technical managers to supervise engineers because the manager/supervisor may not understand the nature of the engineering professional. Badawy (1988) suggests three areas that managers fail to recognize as key de-motivators or negative impacts on engineers' performance:

1. management's failure to reward engineers with motivations unique to their profession versus rewarding them with rewards that appeal to nonprofessionals
2. management's failure to recognize that engineering is inherently creative and should be managed differently from other labor categories
3. management's improper utilization of technical personnel, in that 30% of an engineers time is spent on tasks that someone with a high school diploma could perform. (pp. 27-28)

This suggests that an underutilization of the engineers' talents and abilities as knowledge workers would lead to boredom, a feeling of devaluation and, ultimately, lack of motivation to perform well on the job. Why does it appear that management is so far off the mark in understanding the needs of its technical workforce, especially when most managers in technical/engineering organizations started their careers as journeymen engineers? Krembs (as cited by Al-Faleh, 1991) suggests that several characteristics of engineers as technical managers often emerge: strong ego identification with technical competence, strong achievement drive, low relationship orientation, low levels of a strategic thinking on organizational issues, self-perception as a victim, and fear of technical obsolescence.

Engineering supervisors often exhibit these characteristics, which may contribute to lowering their subordinates' moral, motivation, and performance. I propose to investigate if, in fact, there is a correlation to this in my study. According to Badawy (1988), engineering managers need to keep certain points in mind which are modeled after Maslow's need model:

1. The view that people inherit most of their performance capabilities and are motivated only by reward and punishment has been proved inadequate.

2. Every person has multiple needs. Though the specific forms those needs take are highly individualized, the basic needs, themselves, are shared by everyone.
3. The emergence of needs does follow a specific rigid pattern.
4. A satisfied need is not a motivator of behavior. As one need is fulfilled, another, higher need emerges.
5. It is not necessary to satisfy a "lower" need fully before a "higher" need may emerge and operate as a motivator.
6. There is no universal motivator for all people, nor is there a single motivating force for any one individual.
7. There are individual differences in the most appropriate way for satisfying the same need.
8. Motivation is internal to the individual. A person is not motivated by what people think he ought to have, but rather by what he wants. It follows that management cannot really force or push people to produce.
9. There are factors other than human needs that influence motivation. Among these are the individual's evaluation of himself and his interpretation of his environment. (p. 28)

If we compare the characteristics of engineering managers cited by Al-Faleh (1991) with the list of important points engineering managers should be aware of as argued by Badawy (1988), some gaps are revealed between managers' behavior and their awareness of what motivates engineers. This is further compounded by the engineers' task orientation and managers' management orientation. According to Fayo (as cited by Al-Faleh, 1991),

> . .the main distinction between a management-oriented role and a task-oriented role, as practiced by functional engineers, is that the role of the manager is the management of the three main resources, money, people, and materials; whereas the role of the task oriented engineer is the functional management of the use of these resources. (p. 12)

Similarly, Stogdill and Coons (as referenced by Arvey & Neel, 1974) identified two leadership behavioral styles, an initiating structure style and a consideration style. Basically, leadership initiating structure describes the level at which the supervisor assigns specific tasks, specifies the procedures to be used, and actually schedules the work. Leader consideration style describes the degree to which the supervisor creates an organizational environment of support and friendliness by demonstrating behaviors such as looking out for employees' welfare, advocating for subordinates, and being open, friendly, and approachable. Of these two styles, engineering technical managers would most likely adapt the initiating structure style, which

naturally aligns with their engineering orientation. The question of the effectiveness of these two styles depends in large part on what the employees' expectations of how they should be supervised. Arvey and Neel (1974) conclude in their study that the impact of considerative supervisory behavior style on employee motivation is, to some extent, dependent on employees' expectations or their perceptions of whether their performance will lead to reward outcomes and the value they place on these outcomes. In addition to leadership style, there are several other factors related to supervisor behaviors that influence the motivation of engineers. These factors include conflict, performance rating, and fairness in promotions.

Xin and Pelled (2003) looked at supervisor/subordinate conflict with regard to perceptions of leader behavior. In particular, they focused on the extent to which subordinates perceive supervisors as providing emotional support and encouraging creativity.[10] These two activities can encompass several leadership behaviors, including inspirational leadership and intellectual stimulation (Bass, as cited by Xin & Pelled, 2003).[11] The literature indicates that employees' perceptions and expectations of their supervisors play a significant role in their motivation and performance. Also, the way supervisors perceive their role and the leadership style and behaviors that they adopt also play a significant role in the performance and motivation of their employees.

Another factor that significantly impacts the motivation and performance of engineers is the performance rating process. Specifically, bias in performance ratings can cause serious motivation and performance issues among employees. According to Smith, DiTomaso, and Farris (2002), bias in performance ratings continues to be an area of interest in research because

---

[10] According to Xin and Pelled (2003), ". . .*emotional support* is defined as a leader's tendency to express faith in followers and optimism about their ability to accomplish a task. *Creativity encouragement* is defined as a leader's tendency to promote innovation through processes and task approaches" (p. 27).

[11] According to Bass (as cited by Xin & Pelled, 2003), ". . .an inspirational leader is one who communicates high expectations, uses symbols to focus efforts, and expresses important purposes in simple ways. Intellectually stimulating leaders are willing and able to show their employees new ways of looking at old problems, to teach them to see difficulties as problems to be solved, and to emphasize rational solutions" (p. 27).

of the impact that perceptions of unfairness have on employees, work groups, and organizations. In addressing the question of motivation and performance, consideration must be given to the socio-structural position of different demographic groups (i.e., women, Blacks, Hispanics, and Asians) both in the role of supervisor and employee. Deci (1975) suggests that women's intrinsic motivation decreased with positive feedback, while, in contrast, men's increased. He concludes that this could be attributed to how women are socialized in our society to view feedback as a controlling mechanism, whereas men tend to view feedback as informational. In technical and research and development organizations, most employees hold technical positions, and white males disproportionately hold top positions and positions of authority. This adds yet another dimension to leadership competencies required--namely, managing diversity for the purpose of maximizing motivation and performance. Smith, et al. (2002) concluded in their study that the type of boss one works for and how one is perceived by others makes a difference, over and above any privilege or disadvantage that one may get because of group identification. Does your race, ethnicity, or gender matter at work? Smith et al. (2002) argue that group identity does matter, especially for those individuals who are given the benefit of the doubt regarding their competence because of the demographic group to which they belong. According to Solomon (1990), conformity in the workplace was the rule, including the shirt color. Some managers even think that in order to be fair they should assume everyone is the same. Managers have often proclaimed to not see color or gender, just talented employees.

According to Dickens and Dickens (1982), we are culturally different and our society places different demands on its various groups of people and specifies different roles. We are socialized into believing that certain roles and positions in the workplace are better suited to particular racial, gender, and ethnic groups. According to Jones (1986), most black managers feel that, in order to satisfy the values and expectations of the white corporate culture, they must tread

through a gauntlet of contradictory pressures. This includes maintaining excellent performance even when recognition is withheld. It means being smart, but not too smart; strong, but not too strong; confident, but not egotistical; being the butt of prejudice and not being abrasive; being intelligent, but not arrogant; being honest, but not paranoid; being confident yet modest; and being courageous, but not too courageous as to appear to be a threat to the white male culture. I argue that this tightrope walk applies not only to black managers, but all minority groups to include female, African American, Hispanic, and Asian employees. So, many minorities and women working in a white, male cultural environment must not only put energy into their actual jobs, but must also devote sometimes significant energy into navigating in a culture very different from their own in terms of social norms. A distinguishing factor of the present study is that demographic factors such as race and gender will be considered as an independent influence on engineer motivation.

A third factor that can impact motivation and performance is fairness in promotion and career advancement. Jagacinski, LeBold, and Linden (1987) investigated several hypotheses concerning the differential career advancement of men and women engineers. They found that women tended to achieve higher school grades and class ranks than their male counterparts, and performed as well as men during the college years and received as many job offers as did male graduates. So why then do women engineers advance in their careers at slower rates than their male counterparts? There have been numerous studies on why women do not advance in their careers as quickly as men, given their qualifications. However, there needs to be further research as to the impact the slower advancement has on women's level of motivation and performance. There are larger and more serious impacts that can come from unfairness in performance ratings and unfairness in career advancement as well--such as discrimination lawsuits, as in the case of the class action lawsuit that African American engineers filed against in NASA Goddard in 1993

for unfair promotion practices.[12] NASA ultimately lost the lawsuit and the subsequent judgment levied a number of additional administrative burdens on NASA management. Did NASA's process and administrative changes resulting from the lawsuit have a positive affect on the African American engineers? I propose to investigate this question in my study.

Characteristically, engineering managers appear to be more self-focused and lack people orientation, and they also tend to be more focused on maintaining their own technical competence. Engineering managers perhaps even suffer from *job addiction* to the technical work that they previously performed (Badawy, 1988). As supervisors, managers, and leaders they are required and expected to have a more humanistic approach to their management style, to think strategically about how to motivate their employees, to be interested in the needs of their employees, and to understand the complexity of managing a multitude of individual needs that are constantly changing in an increasingly diverse workforce.

For a technically oriented individual, this could be a dauntingly complex task, necessitating support systems. As previously cited, engineers tend to have an autonomous orientation toward their professional work and may not actively seek support in dealing with complex people-related issues. One possible reason is that it would bring attention to their lack of skill and competence in managing human systems within their organizations. Further research in this area could lead to better training and development programs for technical managers.

The literature is rich with research on how leadership styles, behaviors, and competence affect employee motivation and performance; but the literature also suggests that employees' perceptions and expectations of their supervisor's role play a significant part as well. Are there

[12] On April 19, 1993, Walter Flournoy, an African American engineer employed by the NASA Goddard Space Flight Center (GSFC or Goddard), filed an administrative class complaint of discriminations against NASA GSFC alleging violation of Title VII of the Civil Rights Act of 1964, as amended, 42 U.S.C 2000e et seq. In the administrative complaint, the Class Agent sought declaratory, injunctive, and monetary relief on behalf of himself and the putative class of all African American non-managerial, non-supervisory scientists and engineers at NASA's GSFC who were eligible for, but did not receive, promotions from the GS-13, GS-14, and GS-15 levels.

other factors that affect motivation in addition to supervisor or management behaviors? Perhaps race, gender, or age serve as factors, particularly where it relates to employees' perceptions, expectations, and needs.

The workplace has significantly changed from the 1960s. Diversity among engineers has increased markedly in the past 15 years: nearly 50% of all college engineering majors are women. The National Society of Black Engineers recently reported having 12,000 African American undergraduate members attending college engineering programs across the country (NSBE, 2008). Also, Asian and Hispanic engineering undergraduates have increased in the past two decades (NSF, 2005). As a result, a steady stream of minority engineers has been coming into the workforce over past two decades. Considering the factor of gender, Dryburgh (1999) suggests that women entering the engineering profession not only have to demonstrate competence in knowledge and skill, but also have to adapt to the masculine norms and attitudes associated with the engineering profession. Another demographic factor is age. Arvey and Neel (1974a, 1976) and Wolf, London, Casey, and Pufahl (1995) discovered that age influenced motivation. Arvey and Neel (1976) concluded that supervisors rated the performance of engineers under age 40 as being higher than engineers over age 40. They attributed this to either low motivation or obsolescence, or possibly both. Older engineers are retiring at slower rates, and so there is a much larger generation gap between recent engineering graduates and older engineers. What challenges does this pose for organizations to maintain a highly motivated technical workforce that is much more diverse today than at any point in the last century?

The next section explores the different methods of research used to investigate the various theories of motivation related to engineers. It covers methods used over a period of several decades.

Previous Empirical Studies on Engineer Motivation

I will first look at the early work and then conclude with the most recent research. Several studies focused on Herzberg's et al. (1959) two-factor theory[13] and Vroom's (1964) expectancy theory;[14] both Herzberg and Vroom were major contributors to the body of knowledge concerning work motivation, and both theories generated an abundance of empirical research that resulted in the development of measurement scales to support or challenge these theories.

A study conducted by Graen (1966), utilized psychometric measures using factor analysis. Herzberg et al. (1959) two-factor analysis required that the measurement of the work factors be accomplished through interviews. Graen (1966) developed a questionnaire using Herzberg's classification scheme comprised of a 96-item, 10-point importance scale. This scale was administered to a sample of 153 professional engineers working in design and development for two electronics firms in the Twin Cities (Minneapolis-St. Paul) area. Herzberg, et al. (1959) (as referenced by Graen, 1966) previously used the critical incidents method to interview subjects about prior satisfying or dissatisfying job situations. These interview protocols were then subjected to a content analysis. Subsequent studies have replicated Herzberg et al. (1959) findings using a story-telling method as an approach as well. Graen's (1966) argument was that Herzberg et al. (1959) two-factor analysis was subject to contamination by the rater to the respondents' own perceptions of the job satisfaction dimensions. Graen's (1966) redesign of Herzberg et al. (1959) methodology did not result in the formation of categories or factors from

[13] In 1959, Herzberg et al. used critical incidents to develop the Hygiene-Motivator factors that serve as the basis of his two factor theory. He also developed an approach to studying job attitudes based on his theory--this he referred to as factors-attitude-effects, or FAE complex.

[14] In 1964, Victor Vroom developed Expectancy theory which states that motivation or force is a mathematical function of three types of cognitions: Force = Expectancy x Σ(Valences x Instrumentalities) where *Force* represents the amount of motivation a person demonstrates, *Expectancy* is the subjective probability that a person has about their ability to perform, *Valence* is the value of an outcome or reward to a person, and *Instrumentality* is the subjective probability that a given behavior will result in a particular reward.

the interview data, and he concluded that it is important to conduct empirical validation before establishing categories as if they were distinct and measurable entities. The problem with Graen's (1966) investigation is that he failed to recode the *motivators* and *hygiene factors* so that they would result in homogeneous groupings that create distinct factors that could be correlated.

A study by Goodman, Rose, and Furcon (1970), investigated four approaches for assessing the motivational antecedents of work performance of scientists and engineers. The four approaches were direction of motivation orientation, source of motivational stimulation, job dedication, and an expectancy model. They conducted a survey of 78 scientists and engineers at a government laboratory using both questionnaires and interviews. Goodman et al. (1970) concluded that the results indicate the expectancy model was more useful than direction of motivation orientation, source of motivational stimulation, and job dedication. They argue that the expectancy model has more specificity in addressing the multidimensional nature of motivation and is more specific to the criterion variable. The other models did not possess sufficient complexity and were not specific to the criterion variable. Other criticisms cited by Goodman et al. (1970) relate to the expectancy model, and although the results were encouraging, the direction between reported motivation and performance was not clear. Secondly, there were problems with the expectancy index and there was no retest information that indicates the stability of the index.

Arvey and Neel (1974b) tested the expectancy theory on work motivation or effort versus performance using behaviorally based scales. They sampled 130 engineers at a Southeastern utility company using a five-point scale that measured expectancy corresponding to effort→performance and a second five-point scale measuring performance→reward outcome. Rating scales developed by Landy and Guion (1970) were also completed by the supervisors of these engineers. The results of this study indicate that the relationship between the criteria and

the various expectancy variables was largely negative. Arvey and Neel (1974b) cite several reasons for the failure of the expectancy model to predict the criterion variable:

1. organizational circumstances may not have been within certain boundary conditions for the model to work
2. inadequate "operationalism" of expectancy variable
3. use of job outcomes that were not representative of actual outcomes in the organizational setting
4. criteria problems (p. 307)

One argument is that Landy and Guion's (1970) scales used by Arvey and Neel (1974b) were designed to measure work motivation via peer ratings. The expectancy model was designed to measure motivational effort via supervisor ratings. Also, Arvey and Neel (1974b) attempted to reduce halo effects by using the Landy and Guion (1970) scale; however there was evidence of halo in the criterion measures according to Arvey and Neel (1974b). They further suggest that employee self-rated effort may be a more accurate measure. A surprising result was revealed in the study: expectancy two variables showed different relationships to the criteria as a function of age. For the older group of engineers (age 41 and older), more positive relationships were revealed, whereas mostly negative relationships were revealed for the younger group. Arvey and Neel (1974b) suggest future research be conducted that considers the moderating effects of age on the motivational variables.

This led Arvey and Neel (1976) to conduct another study investigating the motivation of older engineers using the expectancy model. This sample was drawn from a large southeastern utility company. Questionnaires were sent to 165 lead engineers from four disciplines. In this study, supervisors rated the job performance of these engineers also using scales developed by Landy and Guion (1970). Expectancy measures were made by questioning the engineers' expectancies concerning whether job performance would lead to various job outcomes. The results of this study indicate two basic points: (a) older engineers value tasks that make use of their abilities and allow them to show accomplishment; and (b) the data offer some confirmation

on the validity of the expectancy theory as a motivational model for older engineers (Arvey & Neel, 1976). Arvey and Neel's second point is based on their 1974b study put forth above. The same weakness applies to this study in that supervisor ratings were generated using the Landy and Guion (1970) scales which were designed for peer review. The only consideration is that older engineers are more likely to be considered peers to their supervisors, which may explain why they had more positive correlations to the motivation variables than the younger engineers.

Kopelman (1979) used expectancy theory to test two hypotheses: the first is that the multiplicative aspects of the expectancy theory is a better predictor of work motivation and work performance than the discrepancy model of expectancy, and the second is that the discrepancy model is a better predictor of job satisfaction than the multiplicative model. Kopelman (1979) conducted three separate studies; in two of these he sampled 399 design and development engineers and engineering supervisors employed by three large technology-based companies. Four years later, he conducted a retest of 210 of the same engineers from the earlier sample using identical measures. In the third study, Kopelman sampled 1,777 engineers employed by 20 divisions of a large technology-based company. The results of all three of Kopleman's (1979) studies led him to suggest that individuals who see little chance of obtaining outcomes that are highly valued will be less satisfied than individuals who see little chance of obtaining outcomes that have low value. A weakness of the study is that respondents were predominantly white, male engineers so it does not account for gender and race differences in expectancies or valences.

Landy and Guion (1970) constructed seven behaviorally anchored scales to measure the motivation to work. They used focus groups of professional engineers to develop and define dimensions and appropriate behavior items, and a different engineering group to assign scale values to the items in an iterative procedure. The seven dimensions were team attitude, task concentration, independence/self-starter, organizational identification, job curiosity, persistence,

and professional identification. Each dimension had seven or eight items totaling 55 items. The results of this study, according to Landy and Guion (1970), indicate that the scales could be used in a variety of settings, and that none of the raters reported difficulty in applying the scales. Even though the reliabilities were low (the median reliability was .24), they were usable. The scales seem to clearly assess the seven kinds of motivation even though the presence of inter-correlations between scales suggests some kind of halo or other response bias (Landy & Guion, 1970). The organizational identification dimension from Landy and Guion (1970) was very similar to the Organizational Commitment Questionnaire (OCQ) by Mowday, Steers, and Porter (1979).

Mowday et al. (1979) constructed and validated a measure of employee commitment to work organizations. They tested a total of 2,563 employees in nine divergent organizations. Their population included a sample of 119 scientists and engineers employed by a major independent research laboratory in the Midwest. The instrument developed was an Organizational Commitment Questionnaire (OCQ) that consisted of a series of statements that represent possible feelings that individuals might have about the company or organization for which they work. The OCQ had 15 items that included negative statements as well. Items in the OCQ were found to be homogeneous and the overall measure of organizational commitment was stable. Mowday et al. (1979) suggests that their work provided reasonably strong evidence that internal consistency and test-retest reliability of the OCQ was achieved. Another strength of the OCQ is that is was tested across different occupations and across employees with widely divergent demographic characteristics. Also, negatively worded items were included to prevent acquiescence response tendency. A vulnerability cited by Mowday et al. (1979) is that employees may distort their responses if they feel threatened by completing the questionnaire or are unsure of how their responses will be used. In a study by Zeffane (as referenced by Fields, 2002), a factor analysis

found two principle components within the 15 items of the OCQ. The first factor, made up of six items, measured corporate loyalty/citizenship. The second contained nine items that measured attachment to the organization. In another study by Mathieu (as referenced by Fields, 2002), two factors resulting from factor analysis were found. One factor contained nine positively worded items and the other contained six negatively worded items. He found the meaning of the second factor containing the six negatively worded items to be unclear, possibly due to the wording of the items.

Lawler and Hall (1970) conducted a study to investigate job involvement, job satisfaction, and intrinsic motivation of scientists. They sampled 291 scientists in 22 research and development laboratories. Each scientist was asked to complete a short questionnaire that measured job attitudes using a seven-point Likert scale; followed by four other Likert-type items that measured the scientists' perceptions of their positions' *job factors*. Lawler and Hall (1970) next conducted a series of structured interviews focused on the amount of challenge present in their jobs and the way projects were actually carried out in the organizations. Factor analysis was done to determine if the three factors (job involvement, job satisfaction, and intrinsic motivation) were factorially independent and distinct variables. Lawler and Hall (1970) suggest the data generally support the view that it is important to distinguish between satisfaction, involvement, and intrinsic-motivation attitudes, because they load on different factors as indicated in the factor analysis, and they are differentially related to job characteristics and job behavior measures.

Shoura and Singh (1998) used Maslow's hierarchy of needs to examine motivation levels for four levels of engineering staff at a public construction agency. Shoura and Singh (1998) surveyed 42 engineers using a research questionnaire to collect quantitative data and they additionally conducted seven qualitative field surveys using interviews of individuals and focus groups. Each interview was conducted in various group and individual formats. The objective of

their study was to use Maslow's needs theory in developing measurement parameters to evaluate the motivation levels of the engineering staff of the organization. The results of this study indicate that none of the need parameters were considered exceptional by the respondents, since no RF or QI[15] value was exceptionally high. Shoura and Singh (1998) suggested it could be that the technical respondents do not take life too seriously or that they just care less, since the RF and QI parameters were not exceptionally high. In other words, the respondents considered no particular need parameter exceptional. If the respondents' mood at the time they answered the questionnaire biased the results, it certainly raises concern about reliability.

Ivancevich and McMahon (1982) compared the motivational impact of goal setting and performance feedback on four measures of performance, intrinsic and extrinsic satisfaction, and organizational commitment. This work used a quasi-experimental design in which the research was conducted at six separate site locations with a population of approximately 258 discipline engineers working on project teams. Out of the population, 209 engineers participated in the nine-month study; 92% were men between 25 and 45 years of age. Of the six sites, three were randomly selected as the goal setting treatment groups in which the treatment was goal setting and feedback. The other three groups were the non-goal setting group that received only feedback. An analysis of variance (ANOVA) was used for each of the seven dependent variables: control costs, quality control citations, unexcused overtime completion, engineering proficiency rating, intrinsic job satisfaction, extrinsic job satisfaction, and organizational commitment. The results of this study indicate that goal setting, external feedback, and self-generated feedback had varying effects on the seven dependent variables. The feedback analysis revealed that some form of feedback can affect performance and attitudinal variables. The self-

[15] RF: Relevance Factor is obtained from responses to importance questions similarly to QIs and reflects the importance of an issue as viewed by the respondent, (Shoura and Singh 1998, p. 47).
QI: Quality Index is a value for a need parameter developed by averaging scores given by one respondent to the questions relevant to that particular need parameter.

generated feedback was superior in its effect on five of the seven dependent variables. One limitation according to Ivancevich and McMahon (1982) is that this study did not investigate goal setting or self-generate feedback alone, therefore a more complete picture of goal setting and feedback could not be provided.

Wolf, et al. (1995) examined the behavior and outcome of 72 displaced engineers in semester-long training program in technology management. This study was classified as a longitudinal study because it investigated changes in the same subjects over time. The program participants were engineers primarily from the defense industry who had been laid-off six months prior. The program was a federally funded job training and placement program. The majority of the participants were men (65 out of 72) and the average age was 45.3 years. Wolf et al. (1995) studied the displaced engineers in a semester-long program aimed at helping them to enhance their career behavior, increase their knowledge in areas of technology management, and encourage them to be proactive in creating jobs for themselves. Correlation and regression analyses were conducted on three measures: career experience, career motivation, and behavior measures which were gathered directly from instructor and internship supervisor reports, attendance, academic forms, and logs maintained in the students files. The regression results predicting training outcomes indicated that training behaviors contributed positively to outcomes while career experience contributed negatively. I interpreted the results to indicate that engineers who had a positive attitude toward learning benefited and those who maintained an attitude of "that's not how we did it in the old days" did not benefit from the training.

Maki (2001) investigated the work motivators for software engineers using an exploratory case study method. The study was conducted at a 1,500-person organization in the midwest that designs and manufactures items for the US government and international partners. The organization had over 600 engineers, 150 of whom were software engineers and the focus of

the study. The goal of Maki's (2001) study was to investigate work motivators within their real-life context. The data collection method modeled the methods of Herzberg, et al. (1959) in which two pilot studies were conducted using semi-structured interviews. Maki's (2001) analysis consisted of identifying keywords from the transcribed interview recordings and then placing them in a table. They then analyzed the key words and the contexts within which they were used to identify themes among the three categories of the factors-attitudes-effects complex (Herzberg et al., 1959).

Maki's (2001) case study approach using Herzberg, et al. (1959) model is unique, however the choice of using a qualitative method with Herzberg's, et al. (1959) theory, which has been cited in the past for not being empirically based, is a weakness. Maki could have used a survey instrument to measure the factors-attitudes-effects to get empirical data that would more concretely validate her work and provide empirical evidence to Herzberg's, et al. (1959) theory.

The studies that occurred between the late 1960s to late 1970s were during the Cold War and NASA was in full development of the Apollo program. This period of time marked exponential growth in technological advancements that created a demand for engineers and scientists. This might explain the impetus for studies focused on engineers' and scientists' performance, motivation, and job satisfaction. These studies tested the reliability and validity of Vroom (1964) and Herzberg, et al. (1959) theories revealing strengths and weaknesses. An example of weaknesses in Herzberg's, et al. (1959) two-factor theory is that it was based on a qualitative approach; attempts were made to validate it using empirical scales, but there were problems with creating factors as Graen (1966) discovered. Vroom's (1964) expectancy theory showed great promise but it was based on supervisory ratings of workers' performance and outcomes, and as a result was subject to halo effects (Arvey & Neel, 1974).

The use of quasi-experimental and longitudinal methods during the 1980s and 1990s reflects a movement toward new approaches to studying motivation of technical workers. Ivancevich and McMahon's (1982) use of a quasi-experimental design used a more recent theory of motivation: Locke and Latham's (2002) goal setting theory.

There were also studies in the past three decades that produced reliable scales for measuring psychological behaviors related work motivation in industrial organizations. A study by Vandenberg and Scarpello (1992) using the *Satisfaction with my Supervisor* scale (SWMS) investigated management information systems professionals in a software research and development firm. They sampled 100 out of a population of 455. The median age was 34; 59% were female and 97% were white. Confirmatory factor analysis was used, and the validity was evaluated by comparing the SWMSS with the shortened nine-item OCQ scale (Mowday, et al., 1979). Vandenberg and Scapello (1992) reported reliability for the SWMS of .78 and the OCQ of .72.

Sims, Szilagyi, and Keller (1976) investigated job characteristics using the Job Characteristic Inventory (JCI) scale. According to Sims et al. (1976), work motivation is thought by some to be highly related to the characteristics of the work itself. In other words, the non-routine and non-repetitive aspects of the job serve as positive motivators. They used six dimensions of job characteristics: variety, autonomy, task identity, feedback, dealing with others, and friendship opportunities anchored on a five-point Likert scale. They conducted the study in two different environments--the first in a predominantly female organization at a medical center where most of the sample subjects were nurses. The second study was conducted at a petroleum equipment manufacturing plant that was predominantly male and the sample subjects were engineers and managers. The reliability of the JCI scale used in the medical center study was above .70, likewise at the manufacturing plant.

Spreitzer (1995) investigated individual empowerment in the workplace as it related to innovation and creativity. She suggests that empowerment is defined as a concept of self-efficacy or competence resulting in increased intrinsic motivation. This supports Deci's (1975) findings on intrinsic motivation. According to Velthouse (as referenced by Spreitzer, 1995), there are four dimensions of empowerment: meaning, competence, self-determination, and impact. Sprietzer developed a seven-point Likert-type scale based on these indicators, which had a reliability of .72. She conducted a study at a Fortune 50 industrial organization, with a sample consisting of 393 managers randomly selected, of which, 93% were men, 85% white, with an average age of 46 years.

According to Spector (1997), job satisfaction is the degree to which people like their jobs. Spector (1997) conducted numerous studies using the Job Satisfaction Scale (JSS) that considered common job satisfaction facets such as: appreciation, communication, coworkers, benefits, job conditions, nature of the work, organization, policies and procedures, pay, promotion, personal growth, recognition, security, and supervision. Spector's (1997) JSS was a six-point Likert-type scale based on nine of the job satisfaction facets. He sampled 3,067 individuals from several studies that yielded reliabilities ranging from .60 to .91.

This review has served to highlight seminal studies of engineers' motivation over the past four decades. What has been learned? The research suggests a link between work environment, job satisfaction, needs, age, performance, and intrinsic and extrinsic factors as they relate to work motivation. Also, a set of measurement scales that have been validated were developed during this period. Given the timeframe of these studies, researchers did address relevant factors and uncovered new knowledge (e.g., the effect of age on the criterion variable of motivation). The state of motivation research relative to technical employees has evolved in concert with the evolution of motivation theory. Beginning with Maslow (1970) and Herzberg (1971), there were

attempts to design tests for these theories; however, there was little empirical research to validate these theories. Vroom's (1964) theory got wide acceptance and was used often in empirical studies because it was mathematically represented and easier to test; this made it more attractive in technical and industrial organizations.

Summary

This literature review examined several topic areas related to motivation. These areas include a definition of motivation that includes intrinsic and extrinsic elements, the nature of work motivation, leadership and motivation, the nature of the engineering profession, and the impact supervisors have on engineer motivation. What has been learned? The research suggests several links among the key elements of motivation: needs, goals, and rewards. These elements have both an intrinsic aspect as well as an extrinsic aspect that can interact with each other either positively or negatively. Individuals can be both extrinsically and intrinsically motivated in the workplace. Extrinsic factors include a comfortable physical environment, such as office or lab space, temperature, lighting, noise level, and accessibility to refreshments. Intrinsic factors include self-esteem, the desire for strength, achievement, adequacy, mastery, competence, self-determination, confidence, independence, autonomy, feedback, and freedom, as well as a desire for reputation and prestige. The literature reveals employee motivation is linked to the employees themselves, their supervisors, and the organization, (i.e., employees' needs, supervisor behaviors, and the organizational environment). Ideally, all of these must be positively developed to facilitate and support a sense of competence, self-determination, and self-actualization in the employee. This is done by tapping into the needs of the employee while ensuring that the needs of the organization and supervisor are met as well. Another link is between engineering supervisors and the motivation of their engineering subordinates. The literature suggests that engineers are unique in that they utilize science and technology to better the lives of humankind,

and that the nature of the profession is serving. Engineers today have more of an organizational loyalty than a professional loyalty;--their intrinsic motivation is rooted more in the mission and goals of the organization in which they work than in their professional identity. Engineers today are also viewed as *knowledge workers* with highly specific knowledge and skills, and therefore they are motivated by different factors. The theories of Maslow (1970), Vroom (1964), Herzberg (1971), and Deci (1975) all suggest an evolving self that requires different reward systems for performance. Pay and punishment are no longer effective in motivating engineers. Today, the new motivating forces for engineers are innovation, recognition, contribution, status, and the ability to control one's own work.

The literature also suggests that technical managers and supervisors are required to have higher skills and competencies related to managing people. Their interpersonal skills are more important than their technical skills, and being in tune with their employees' motivational needs is a complex task. There are also impacts related to bias in performance rating and inequities in employee advancement and promotion. The literature revealed that demographic factors play a significant role in the relationship between supervisor and employee. According to Lefkowitz (2000), considerable evidence exist that performance appraisal evaluations are influenced by a host of affective, motivational, and interpersonal factors. Because often the employee's career advancement is at stake, many investigators have been concerned with the effects of liking, or *halo*, as a source of bias in performance appraisals. Xin and Pelled (2003) suggest that subordinates pay a price when the quality of the supervisor-subordinate relationship is low. This could explain the experience of African American engineers at NASA which led to the class action lawsuit filed in 1996.

Engineers are worth studying as professionals because of their apparent intrinsic motivation to create and innovate using the physical laws of nature and technology. Engineers

prefer a lot of autonomy and independence, and recognition of their technical expertise and contributions are important motivators. There is a need for further study of engineers' motivation that takes into account changes in the profession related to increased diversity, rapid changes in technology, changes in gender roles related to family life, older engineers retiring at slower rates, and the shift to information-based organizations. Most of the previous work was done in manufacturing organizations or research and development laboratories with predominantly white, male workforces. This study specifically investigated female engineers and African American engineers. In addition, NASA engineers who comprise a significant part of the government engineering workforce have not been studied in-depth like their private industry counterparts, as the literature suggests. My objective in this study was to identify factors that account for the positive or negative effects of NASA engineer's level of motivation, with the goal of applying my methodology to the general population of scientists and engineers working in federal laboratories across the country. The findings of my study will be shared with NASA management and human capital management personnel with the intended purpose of enhancing management and leadership training and development and coaching programs at NASA and at the federal laboratories that employ engineers and scientists across the country.

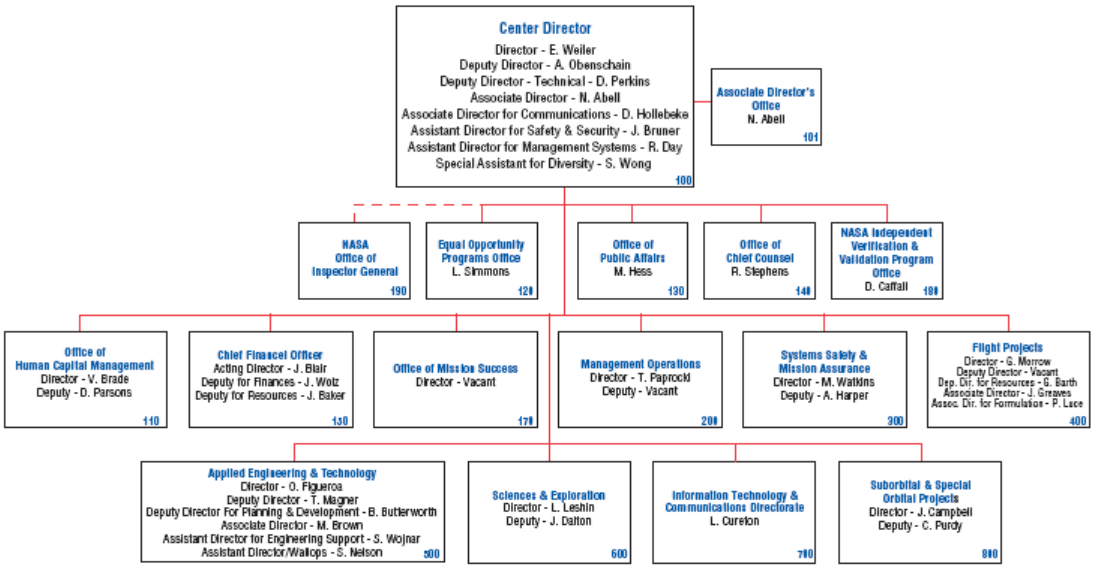
NASA engineers may not develop the one ounce cell phone, or the one and a half pound laptop like their private sector counterpart, which will quickly be surpassed by a faster and lighter version. But, a NASA engineer may be part of a project team that develops a deep space observatory that discovers intelligent life on a distant planet. That happens only once in the history of humankind, and that is an incredible legacy to pass on to future generations!

My next chapter examines the methodological approach that I propose to use for this study.

Chapter III: Method

This chapter presents the research setting and study design, describes the survey participants and research instrument, and describes the method used to collect, manage, and analyze the data. This study was conducted at the NASA Goddard Space Flight Center located in Greenbelt, MD, about 17 miles outside of Washington, DC. As previously stated, the Goddard center is one of nine NASA centers, whose primary focus is on Earth and Space Science Research. Approximately 3,000 civil servant employee's work at Goddard and another 8,000 contractor employees work at the center. Goddard is divided among 16 organizations referred to as directorates. Each directorate is responsible for a major function of the center, ranging from science and exploration to human capital management.

Figure 3.1 NASA Goddard organizational chart (2007).



This study focuses on a specific directorate, the Applied Engineering and Technology Directorate (AETD), which is the largest and employs approximately 1,000 engineers. AETD has five engineering divisions (see Figure 1.1): mechanical systems, instrument systems and

technology, electrical engineering, information systems, and mission engineering and systems analysis. Each division represents a specific engineering discipline and within each division there are several branches that focus on sub-disciplines.

Design of the Study

A multiple regression model was used to explore the predictive nature of specific factors' positive or negative influence on NASA engineers' level of motivation. I developed a survey instrument that is a compilation of several previously validated scales, plus questions that I created for measuring the overall level of motivation, questions specific to the organization, and questions to collect demographic information. Each scale measured specific factors--supervisor behaviors, intrinsic factors, extrinsic factors, and demographic factors--that I posited to have an effect on the motivation level of the engineers working in the AETD.

I used two scales to measure level of motivation: the first was a simple one-item asking respondents to rate their current level of motivation on a scale of 1 to 7. The second scale I used as a dependent variable was the Organizational Commitment Quotient (OCQ) developed by Mowday, et al. (1979). The scale was a seven-point Likert- type scale composed of 15 questions. Response categories ranged from strongly disagree to strongly agree. I chose this scale because it was previously used in an engineering study. The questions in this scale explored feelings related to productivity, organizational values alignment, willingness to put forth effort beyond normal expectations, and excitedly talking about work with others. Some of the questions were negatively worded to measure the level of negative motivation (e.g., "very little loyalty to organization," "nothing special about this organization," and "values are in conflict with organization's policies). Based on some of the characteristics described by Schein (1999), Kantor (1997), and Arvey and Neel (1974) that motivate employees in the work place and Al-Faleh's

(2002) argument the engineers today have a strong organizational affiliation, I posited that the OCQ scale would serve as a good measure of engineers' motivation.

The scales used for measuring the potential predictor variables are specific to each of the three factors and were taken from Fields' (2002) compendium of validated scales for measuring how employees view their work and organizations. I measured the management behaviors using the Satisfaction With My Supervisor (SWMS) scale developed by Vandenberg and Scarpello (1992). The SWMS scale measures employees' satisfaction with their immediate supervisor. It was developed over a three-year period using 2,000 employees from seven manufacturing companies. The scale consists of 18 items using a five-point Likert-type scale. The response categories ranged from very dissatisfied to very satisfied. Examples of the items include: shows concern, listens well, shows appreciation, trusts employees' abilities, and supports employees' career goals. These items are consistent with Xin and Pelled (2003), Al-Faleh (1991), Badawy (1988), and Arvey and Neel's (1974) description of supervisor behaviors and characteristics essential for eliciting high motivation in subordinates. I measured the intrinsic factors--the second potential explanatory factor--using two scales: the Job Characteristics Inventory (JCI) developed by Sims, et al. (1976), and the Empowerment at Work scale (EWS) developed by Spreitzer (1995). The JCI uses 30 items that can be grouped into six subscales. I used two of the subscales that measure autonomy or self-determination and feedback, consisting of ten items total. The response categories ranged from very little to very much. The EWS consists of four subscales totaling 12 items. I used one subscale with three items that measures competence or a person's level self-efficacy. These scales were chosen based on Deci's (1975) argument that self-determination, self-efficacy, and feedback were determinants of level intrinsic motivation. The third potential explanatory variable consists of extrinsic factors. I measured this factor using five facets of Spector's (1997) Job Satisfaction Survey (JSS). The five facets include pay, promotion,

benefits, rewards, and policy consisting of a total 18 items. The response categories ranged from disagree very much to agree very much. According to Spector (1997), job satisfaction is a measure of how people feel about their jobs and provides an attitudinal perspective. Jagacinski, LeBold, and Linden (1987) argue that promotion and career advancement are important factors that affect work motivation. I also added two policy questions specific to NASA Goddard relating to full cost accounting and administrative processes.

The fourth factor that I hypothesized to have an effect on motivation is demographic. The demographic data collected were: age, gender, race, and years of experience, education, and engineering discipline. These data were collected using a questionnaire that I developed. Previous studies of engineers' motivation by Herzberg et al. (1959), Vroom (1964), Landy and Guion (1970), Arvey and Neel (1974), and Kopelman (1977) were conducted when the engineering work force was not as demographically diverse as it is today. My study is intended to account for the increased diversity of the engineering workforce that the previous work was not able to do. According to Jones (1986) and Dryburgh (1999), women and African Americans have the added burden of conforming and adapting to the white, male social norms and culture that tends to dominate many workplace environments. I also chose to specifically investigate African American engineers' motivation level in light of the class action lawsuit previously mentioned in chapter 2. My study focused on a government organization versus private industry. The salary scales, bonuses, and profit sharing for private industry offer an advantage over government organizations doing the same work. I hypothesized that engineers working for NASA have positive motivation, which compensates for the high salaries that their engineering counterparts make in private industry.

Study Population and Sample

As previously stated, the study population was the engineers in the AET Directorate. I obtained a listing of the engineers from the Office of Human Capital Management. I sampled the population based on race, gender, age, years at NASA, and engineering discipline. The intended goal was to get at least a 30% (259 respondents) sampling of the current population of 863 engineers in AETD. In order to ensure adequate representation female engineers as well as engineers from the different racial groups, I used a stratified sampling method based on the following groups: white male, white female, African American, and all other races. To ensure a suitable sample of respondents for each of the groups, I sampled them at different rates. The rates were: 40% of white males, 100% of white females, 100% African Americans, and 50% all other races. I chose to over- sample the African Americans and females to make it possible to run separate analyses for females and African Americans. The over- sampling of African Americans and females also requires that when conducting analysis of the whole sample, I weight the responses for the respondents from these groups so that the sample represents the population of engineers proportionately. The actual population that I used after eliminating technicians, managers, and student interns totaled 863 out of the original list of 1,000. After applying the sampling rates to the 863 engineers I had a sample size of 526 engineers.

Reliability and Validity

Each of the scales has sound psychometric properties. The following reliability and validity data are cited in Fields (2002). The OCQ has coefficient alpha values ranging from .81 to .93. OCQ correlated positively with sub-factors such as job satisfaction, job involvement, and task feedback. The SWMS scale has coefficient alpha values ranging from .95 to .96 and confirmatory factor analysis of the 18 items found that they loaded on two factors. The JCI scale has coefficient alpha values that range from .76 to .84 and the EWS scale has alpha values ranging from .81 to .87. The JCI subscales for autonomy, feedback, and identity correlate

positively with satisfaction with growth and supervision. The EWS factor analysis showed that competence and self-determination correlated positively with job satisfaction. The JSS has a coefficient alpha value of .89 and the nine facets were all positively intercorrelated (Spector, 1997). The actual reliability values based on the data collected for this study were calculated and the results are presented in chapter 5.

Data Collection

The data were collected via a web- based survey (see Appendix A) created using Survey Monkey. The website is http://www.surveymonkey.com. The individual items for each scale were used to create the survey, totaling approximately 41 questions including the demographic information. Arrangements were made with the Office of Human Capital Management (OHCM) to obtain the names and emails of the engineers working in AETD. I also obtained letters of endorsement from the Director of the Office of Human Capital Management and Director of the AETD supporting this study (see Appendix B). I also provided a series of briefings to each of the engineering division managers in AETD and requested their full support in encouraging their engineers to participate in the study. A total of three weeks was used to complete the data collection and reminder emails were sent out each week to the engineers encouraging their participation during the data collection period. Once the data collection period was completed, I counted the total number of responses to determine if it met the minimum of 30% response--260 responses out of a population of 863. Relative to the 526 engineers actually sampled, 260 responses represented a 50% response rate. I then conducted some data cleaning to eliminate partially completed cases and ensured that the demographic questions were answered. For the cases where the respondent selected “Other” as their race, or left it blank, I checked the appropriate box based on how their race was listed in the official NASA database. After the data cleaning, there were a total of 238 usable cases with which to conduct my data analysis.

Data Analysis

The resulting data from the survey instrument were analyzed using SPSS Statistical Software based on Field's (2005), George and Mallery's (2005), Mertler and Vannatta's (2005) and Blaikie's (2003) recommended approaches. I conducted an initial data cleaning doing a visual check to look for missing data. I then ran box plots and stem and leaf plots to check for outliers and checked for normal distribution of the data in the form of skewness and kurtosis. I calculated descriptive statistics for the mean score, mode, median, range, and standard deviation of all the variables. In order to ensure that the scales developed and validated on other populations by other researchers were appropriate for my sample of engineers, I conducted exploratory factor analysis on each of the scales: OCQ, SWMSS, JCI, EWS, and JSS. I also suppressed factor loadings of absolute value of .35 or less, this decision was based on Steven's (as referenced by Field, 2005) suggestion this cutoff point was appropriate for interpretive purposes (p. 659). I chose to use orthogonal rotation using the Varimax which maximizes the dispersion of loadings with in the factors.

The factor analysis process facilitated my becoming adequately familiar with my data before conducting the regression analysis. Prior to selecting my approach to the regression analysis, I considered several options. They included:

1. Entering all the variables (questions) of each scale as predictor variables in the equation together as one set (e.g., all the demographic variables, all the supervisor variables, all the intrinsic variables, and then all the extrinsic variables against response variable motivation).
2. Entering the single factors that resulted from the factor analysis for each of the scales together as predictor variables against the response variable (motivation).

3. Entering each single factor that resulted from the factor analysis and entering them into the regression formula in blocks in a prescribed, stepwise order.

I chose to use the third approach and conduct a multiple regression in a hierarchical manner. The predictor variables were entered into the regression equation on a block-by-block manner based on a theoretical approach. I first controlled on demographic variables: African Americans, females, and age. Next, project and administrative supervisors variables; followed by intrinsic factors; and finally, extrinsic factors were added to the regression model. I chose this approach based on the literature review that indicates supervisor behaviors and intrinsic factors have a potentially stronger influence on motivation than extrinsic factors. Also, the literature suggested that gender and age were factors that influenced motivation. I also wanted to investigate potential demographic affects of African American engineers versus non-African American engineers based on past NASA Goddard organizational issues related to the class action lawsuit cited in chapter 2.

I chose multiple regression analysis because this approach will inform me as to which set of predictor variables accounted for the most variance in the response variables, motivation and OCQ. A hierarchical approach was used to run the regression analysis in a block-by-block sequence. Before the regression analysis could be run, dummy variables were created for the demographic groups because they were categorical variables, not interval data. This was done by recoding them into variables with a value of "1" or "0." For race, African American was RaceDum_AA = 1 and all other races = 0. I created dummy variables similarly for all the other demographic groups: RaceDum_APAC, RaceDum_Hisp, RaceDum_Nat, RaceDum_NonWhite, RaceDum_NonAAMinorities, and RaceDum_White.

The final output indicated the beta values (B), beta coefficients (β), and multiple correlation coefficient (R), and the coefficient of multiple determination (R^2). R^2 is interpreted as the

proportion of variability in the level of motivation of the engineers in the study. The regression equation for this study is:

$$R^2_{\text{Engineer Motivation}} = B_{\text{AA}} X_{\text{AA}} + B_{\text{Supr Behavior}} X_{\text{Supr Behavior}} + B_{\text{intrinsic}} X_{\text{intrinsic}} + B_{\text{extrinsic}} X_{\text{extrinsic}} + e'$$

The following is an example of my regression table.

Table 3.1

Summary of Hierarchical Regression Analysis for Variables Predicting Motivation Levels of NASA Goddard Engineers. (N=238)

Variable	*B*	*SE B*	*β*	*R*	R^2	ΔR^2
Block 1						
Race						
Female						
Age						
Block 2						
Race						
Female						
Age						
Admin_Supr						
Proj_Supr						
Block 3						
Race						
Female						
Age						

	Proj_Supr
	Admin_Supr
	Autonomy
	Feedback
	Competence
Block 4	
	Race
	Female
	Age
	Proj_Supr
	Admin_Supr
	Autonomy
	Feedback
	Competence
	Promotion
	Benrwds
	Policy

Note: The actual output table will contain only those variables that significantly contribute to predicting motivation.

Summary

This chapter described the methods used to collect and analyze data on the factors that predict the level of motivation of NASA Goddard engineers working in the AET Directorate. A stratified, random sampling method was used to obtain a sample of the population of 863 engineers. A web-based survey was used to gather quantitative data. Factor analysis and multiple

regression analysis were used in a hierarchical manner to determine which of the predictor variables most influenced the motivation which was the response variable.

Chapter IV: Pilot Study

I ran two pilot surveys: one with several NASA colleagues, and the second one with a small sample from the population being investigated. I received the following feedback from participants in the first pilot:

1. **“**Be careful of people misreading the negatively worded statements. Also, many of the statements seem to restate the same concept (perhaps this was intended).”
2. **“**The length was fine and the questions were clear. There was a problem with the last page--when ‘other’ is selected; it still requires a response from one of the predefined choices. Please let me know the results of the survey. Much success on your dissertation.”
3. “Length and clarity are fine. Questions about the ’organization‘ may have been answered differently depending on how ’organization‘ is defined. NASA, GSFC, AETD, Code, Project, etc. . . .”

The second pilot study was conducted using a small sample of engineers from the population that served as the focus of this study. The pilot participants provided the following feedback and comments:

1. ”The negative questions such as ‘I do not. . .’ are confusing, especially when you have to answer that ‘I disagree that I do not. . .’ Some of the questions were a bit vague or did not seem to match well with the selection options. Some of the questions appeared redundant. Perhaps for matrix employees you could optionally answer for both under the same question.”
2. **“**Only comment I have is this survey can be misleading; i.e, a lot of folks including myself are matrixed out from AETD to support a specific project. My response to this survey is targeted to my home organization in AETD and the corresponding

management. Answers to these questions addressed to the project I support full time would be very different. . . that aspect is not captured here. I assumed feedback for this survey is more productive to my home organization as they are directly responsible for any promotion related issues and my long-term allegiance."

3. "I think we are doing more with less resources (people), less time (schedule), and more regulations (ITAR, IP security, contract management, more reviews). But somehow we manage to do it! Ability to do internal research is limited by resources and fierce competition."
4. **"**Thanks for doing this Howard."
5. **"**A question on the first page (#5-10, don't remember exactly which one) is repeated."
6. **"**Salary questions are not properly formulated for those at the GS-15 technical grade."

The feedback from the pilot surveys was very informative and themes emerged. There was confusion among several respondents regarding the negatively worded questions, which presented itself in the results, particularly with the OCQ scale. There was also confusion regarding what the respondents considered to be their home organization, for example, AETD, division, branch, or project, which would have affected how they answered some of the questions. Generally, the feedback was very positive: most indicated the length and number of questions was fine and they appreciated my undertaking this particular study.

Chapter V: Results

This chapter presents the results of the study. The following data will be presented: total number of participants who either fully or partially completed the survey; breakdown by the demographic groupings; descriptive statistics including mean score, mode, median, standard deviation, skewness, and kurtosis of all the variables (see Appendix G); new variables created from the factor analysis; data reduction results; reliability coefficient values; multiple correlation coefficients; and multiple regression analysis results.

As previously stated in chapter 3, the total sample size was 526, and 260 engineers responded to the survey. The survey data were exported from Survey Monkey to Microsoft Excel to better facilitate reformatting the data set before it was imported into SPSS v13.0. Once the data were in SPSS, I named the variables, assigned labels, and set all of the column headings for my data type. Next, I conducted an initial screening of the data to remove responses that were not fully completed. This resulted in 20 respondents being removed; two more were removed because their responses were highly skewed and/or had outliers on most of the questions. I also found that 18 respondents selected “Other” for race, and two respondents did not select a race or gender--I therefore used the race and gender data from the NASA Office of Human Capital Management spreadsheet to code in the values for those 20 respondents. This resulted in 238 usable responses.

Overall Response Rate

I ran a frequency response on the demographic information to see how closely the actual demographic responses matched the population based on the sampling rate, and to calculate the weights that were assigned to each of the racial demographic variables as discussed in chapter 3. Table 5.1 shows the sample size, sampling rate, response rate, and the calculated weights for the four demographic groups.

Table 5.1

Sample Size Compared to Response Rate and Weights

Group	Population	Sample rate	Sample Size	N (Respondents)	Weight	Weighted "N"
AA Male	52	1.0	52	32	0.50	16
All Female	187	1.0	187	100	0.58	57.54
White Male	496	0.4	198	79	1.93	152.62
Other Male	126	0.5	64	27	1.44	38.77
Total	861		501	238		264.92

The weights for each demographic group were calculated using the inverse proportion to their sampling rate x the inverse proportion of the response rate) / .5. The weights were used for the factor and regression analyses to ensure the sample size for each demographic group was proportional to the population demographic groups.

Descriptive Statistics

Descriptive statistics were run on all the variables to assess the data for normal distribution and check for any skewness and kurtosis. Appendix F contains the SPSS descriptive frequency output for all of the variables. Several variables revealed some skewness and kurtosis. A kurtosis or skewness value between $\pm$ 1 is considered excellent for most psychometric variables. However a value of $\pm$ 2 is also acceptable in many cases (George & Mallery, 2005). I used the more liberal criterion of $\pm$ 2 because my population is a very select group of professionals. The competence scale exhibited significant kurtosis because of the feeling of high competence among the engineers. Table 5.2 lists the variables that had significant kurtosis values.

Table 5.2

Variables with Significant Kurtosis

Variable	Kurtosis value
OCQ_Mot1 (willing to put in a great deal of effort beyond normal)	3.76.
JCI_Autonomy1 (how much you are left alone to do your own work)	3.68
JCI_Autonomy2 (the extent that you can act independent of your supervisor)	2.36
EWS_Competence1 (confidence about ability to do my job)	4.51
EWS_Competenc2 (self-assured about capabilities to perform work activities)	4.37.

Reliability

To determine how well the variables reliably measured what was intended, I ran a reliability test to get a value for Chronbach alpha coefficient of each scale. The actual Chronbach alpha values for this study compare favorably to the values cited by previous researchers.

Table 5.3

Reliability of Each Scale

Scale	Chronbach Alpha α
OCQ*	.79
SWMS - Project Supervisor	.96
SWMS - Admin Supervisor	.97
JCI - Autonomy & Feedback	.86
EWS - Competence	.94
JSS* - pay, promotion, benefits, rewards & policy	.81
HK* – policy	.82

* Includes reverse scored items

All of the reliability values were consistent with Fields' (2002) findings and previous studies that used these scales as discussed in chapter 2 of this work. I created the HK policy variables to address specific policies in place at NASA Goddard and they revealed reliability greater than .70. Kline (as referenced by Fields, 2002) suggests that scales using psychological constructs can realistically be expected to have values less than .70.

Factor Analysis

For the Principal Component Analysis (PCA) I applied three rules: absolute loading values < .35 were suppressed, variables that loaded on more than one component (=>.35) were removed, and Varimax rotation with Kaiser normalization was used. These rules were based on Stevens' (as referenced by Fields, 2002) recommendation that, for sample size of 200, the loading of an absolute value should be around .364--I had 238 in my sample size so I chose .35. I also wanted to maximize my dispersion of loadings to load a smaller number of variables highly onto each factor by using Varimax rotation.

I first ran the factor analysis with all 15 variables, but could not get it to load on one scale as had been found in the original and subsequent validating studies. Component one contained three variables: OCQR_Mot15 ("deciding to work for this organization was a mistake"), OCQ_Mot10 ("I am extremely glad I chose this organization over others"), and OCQ_Mot13 ("I really care about the fate of this organization"). Component two contained two variables: OCQR_Mot7 ("could work for a different organization even if work was similar") and OCQ_Mot4 ("would accept almost any type of work to stay with this organization"). I determined that the two factors were not that distinct from each other, and the negatively worded statements caused some confusion with the respondents which was also experienced by other researchers as noted in the literature review. Before the final run was conducted, I eliminated the, OCQ_Mot1 ("willing to put in a great deal of effort beyond normal") variable because it

exhibited a high kurtosis of 3.76. The final run used the Shortened OCQ scale (Fields, 2002) that contained only the nine positively worded statements. Following the decision rules described above, the Principal Component Analysis resulted in the following factor. Table 5.5 shows the items that loaded on this factor.

Table 5.4

OCQ Scale Factor Analysis Variables

Variable Name	Item
OCQ_Mot2	Talk up organization to friends very positively
OCQ_Mot4	Would accept almost any job to stay with this organization
OCQ_Mot5	My values and organization values are similar
OCQ_Mot6	Proud to tell others I am part of this organization
OCQ_Mot8	This organization inspires my very best performance

The theme of this set of variables relates to organizational loyalty and pride, and although it does not directly represent a measure of the motivation construct as I defined it for this study, it is still very useful as a response variable measuring the loyalty and pride the engineers have for NASA Goddard.

The mean score of these five variables was calculated to create a new variable called OCQ_Motivation. I similarly ran factor analysis on all of the remaining variables and calculated their mean scores to create an additional eight new variables with the following names: Proj_Supr, Admin_Supr2, Autonomy, Feedback, Competence, Promotion, Benrwds, and Policy. The following tables show the variables that make up each factor.

Table 5.5

Proj_Supr Scale Factor Variables

Variable Name	Items
SWMS_Projsupr1	The way my supervisor listens
SWMS_Projsupr2	The way my supervisor sets clear goals
SWMS_Projsupr3	The way my supervisor treats me when I make a mistake
SWMS_Projsupr4	The way my supervisor is consistent in behavior toward subordinates
SWMS_Projsupr5	The way my supervisor helps me get the job done
SWMS_Projsupr6	The way my supervisor gives me credit for my ideas
SWMS_Projsupr7	The way my supervisor gives me clear instruction
SWMS_Projsupr8	The way my supervisor informs about work changes ahead of time
SWMS_Projsupr9	The way my supervisor follows through to get problems solved
SWMS_Projsupr10	The way my supervisor understands problems I may face in the job
SWMS_Projsupr11	The way my supervisor shows concern for my career progress
SWMS_Projsupr12	My supervisor’s backing me up with other management
SWMS_Projsupr13	The frequency with which I get a pat on the back for work
SWMS_Projsupr14	The technical competence of my supervisor
SWMS_Projsupr15	The amount of time I get to work on a task before being moved
SWMS_Projsupr16	The time I have to do the job right
SWMS_Projsupr17	The way my job responsibilities are clearly defined

Table 5.6

Admin_Supr2 Scale Items

Variable Name	Item
SWMS_Adminsupr1	The way my supervisor listens
SWMS_Adminsupr3	The way my supervisor treats me when I make a mistake
SWMS_Adminsupr11	The way my supervisor shows concern for my career progress

There was a noticeable difference between the project supervisor scale variables (see tables 5.5) and the administrative supervisor scale variables (see table and 5.6). All 17 of the project supervisor items in Table 5.5 loaded on one factor. However as shown in Table 5.6 only three of the administrative supervisor variables loaded on one factor. This is most likely due a function of the amount of daily interaction respondents have with their administrative supervisor--which is significantly less than with their project supervisor, resulting from the matrix management structure of the engineering directorate.

All of the variables in the autonomy scale loaded onto one factor.

Table 5.7

JCI_Autonomy Scale Variables

Variable Name	Item
JCI_Autonomy1	How much you are left alone to do own work
JCI_Autonomy2	The extent you can act independent of your supervisor
JCI_Autonomy3	The extent you can act independent of others
JCI_Autonomy4	The freedom to do what I want on my job
JCI_Autonomy5	The opportunity for independent thought and action

JCI_Autonomy6	The control over the pace of my work

All of the feedback variables loaded onto one factor.

Table 5.8

JCI_Feedback Scale Variables

Variable Name	Items
JCI_Feedback1	The extent you know how well you perform as you work
JCI_Feedback2	The extent you get information from supervisor on performance
JCI_Feedback3	Feedback form supervisor on how well I'm doing
JCI_Feedback4	Opportunity to find out how well I'm doing
JCI_Feedback5	The feeling of knowing if I'm doing well or poorly

All of the competence variables loaded onto one factor as well.

Table 5.9

EWS_Competence Scale Items

Variable Name	Items
EWS_Competence1	Confidence about ability to do my job
EWS_Competence2	Self-assured about capabilities to perform work activities
EWS_Competence3	Mastered the skills necessary for my job.

For the JSS scale on pay and promotion, three of the items did not load onto a single factor; these were the negatively worded questions that most likely caused confusion with the respondents, so they were removed. The removed items were: "raises are too few and far

between", "I feel unappreciated by what they pay me", and "there is too little chance for promotion on my job". Table 5.10 lists the items that did load on the factor.

Table 5.10

Pay and Promotion Scale Items

Variable	Items
JSS_PayPromo1	Feel I am paid a fair amount for work
JSS_Paypromo4	Feel satisfied with chances of salary increases
JSS_Paypromo6	Those who do well stand a fair chance of being promoted
JSS_Paypromo7	People get ahead as fast here as they do other places
JSS_Paypromo8	I am satisfied with my chances for promotion

Three of the benefits and rewards items did not load on the single factor. Again, this may have been a result of confusion due to the wording of the items. The items which were removed were: "I am not satisfied with benefits", "the benefits are as good as other organizations", and "the benefit package is equitable".

Table 5.11

Benefits and Rewards Scale

Variable	Items
JSS_Benrwds4	When I do a good job, I get recognition for it
JSSR_Benrwds5	Do not feel work is appreciated
JSSR_Benrwds6	Few rewards for those who work here
JSSR_Benrwds7	Don't feel my efforts are rewarded the way the should

Table 5.12 revealed that only three variables loaded on the policy factor most likely because the questions were not very clear to the respondents. Those items that did not load were: "rules and procedures make my job difficult", "my efforts to do good job are seldom blocked by red tape", and "I have too much to do at work".

Table 5.12

Policy Scale

Variable	Label
JSSR_Policy4	Too much paperwork
HKR_Policy4	Accounting procedures take too much time
HKR_Policy5	Administrative processes interfere with technical work

Running the factor analysis and then computing the mean score for each of the new factors resulted in condensing the 87 variables in my survey to ten variables that were used to run the multiple regression analysis. Descriptive statistics run on the nine new variables and the single item 7-point motivation scales are shown in Table 5.13.

Table 5.13

Descriptive Statistics for New Variables

Variable	Mean	Median	Mode	SD	Skewness	Kurtosis	Min/Max
Engineers (N = 238)							
Mot_Scale	5.31	6.00	6	1.171	-.742	.362	2/7
OCQ_Motivation	4.70	4.80	5	1.193	-.330	-.388	1/7
Proj_Supr	3.96	4.00	4	.746	-.931	.932	1/5
Admin_Supr2	3.86	4.00	5	.933	-.678	.037	1/5
Autonomy	4.16	4.17	5	.625	-.582	.025	1/5

Feedback	3.35	3.41	4	.969	-.438	-.518	1/5
Competence	6.13	6.33	7	1.031	-1.768	3.752	2/7
Promotion	3.64	3.80	4	1.068	-.399	-.143	1/6
Benrewds	4.05	4.00	4	.917	.048	-.175	2/6
Policy	2.94	3.00	3	1.097	.053	-.171	1/6

Regression Analysis

The final step in the analysis was to run the regression analysis to determine the predictive ability of the independent variables in determining the level of motivation of NASA engineers. Two measures of motivation were used, the motivation scale of 1 to 7 and the OCQ scale. A correlation of the motivation scale variable and the new OCQ_Motivation scale was run to determine how closely they correlated. This resulted in $r = .40$, $p < .01$, so there was a moderate correlation, but not strong, and for this reason the regression analyses was run for each response variable separately. There were also two types of supervisors: project and administrative. Some respondents had both supervisors and some only reported to one type of supervisor. A crosstabulation using unweighted data of the Admin_supr against the Proj_supr revealed that eight respondents selected neither supervisor, 183 had both types of supervisors, 44 only had administrative supervisors, and 31 only had project supervisors. Only cases where the respondent had both a project and administrative supervisor were included in the regression analysis. Although I could have run the regression on each supervisor separately, it was not my intent to investigate the different effects of the project supervisor versus the administrative supervisor in this study. The 44 engineers who indicated they only had an administrative supervisor are most likely categorized as possessing critical skills but in transition because they are in between projects, or available for work because there are difficulties in placing them on projects.

The regression analysis focused on the 183 cases using weighted data. Analyses for the motivation scale and the OCQ scales were run separately.

The first regression run used the Mot_Scale as the dependent variable and the following independent variables: RaceDum_AA, Sex_Female, and Age50over in block 1; Admin_Supr and Proj_Supr for the supervisor behavior factors in block 2; Autonomy, Feedback and Competence for the intrinsic factors in block 3; and Promotion, Benrwds and Policy for the extrinsic factors in block 4. The output is shown in Table 5.14.

Table 5.14

Regression Analysis for Motivation Scale of 1 to 7 Using Weighted Data. (N=183)

Variable	*B*	*SE B*	*β*	*R*	R^2	ΔR^2
Step 1				.282	.078	.078
Age	.297	.075	.282	---	---	---
Step 2				.546	.298	.220
Age	.262	.066	.249	---	---	---
Proj_Supr	.750	.100	.468	---	---	---
Step 3				.606	.375	.077
Age	.204	.064	.194	---	---	---
Proj_Supr	.694	.096	.433	---	---	---
Competence	.346	.078	.272			
Step 4				.629	.400	.025
Age	.209	.063	.199	---	---	---
Proj_Supr	.560	.105	.350	---	---	---
Competence	.274	.080	.215	---	---	---
Feedback	.243	.084	.198	---	---	---
Step 5				.642	.415	.014
Age	.211	.062	.201	---	---	---
Proj_Supr	.512	.106	.319	---	---	---
Competence	.276	.079	.217	---	---	---
Feedback	.192	.086	.150	---	---	---
Benrwds	.186	.082	.143	---	---	---

Note: All variables significant $p < .05$, two tailed

Step five of Table 5.15 resulted in five independent variables that explained 41.5% of the variability of the Mot_Scale. They were: Age50over, Proj_Supr, Competence, Feedback, and Benrwds. The RaceDum_AA variable was excluded because its *B* coefficient value was not significant. Proj_Supr (*B* = .512) had the greatest amount of influence on motivation followed by Competence (*B* = .276), Age50over (*B* = .211), Feedback (*B* = .192), and Benrwds (*B* = .186).

The second set of regression calculations were run using the OCQ_Motivation scale in place of the Motivation scale of 1 to 7 with the weighted data. The exact same sequence of predictors variables were used with the OCQ_Motivation scale. Table 5.15 shows the results. The only variables that were included in the final run for each set were: Proj_Supr, Admin_Supr2, and Benrwds.

Table 5.15

Regression Analysis for OCQ_Motivation using weighted *Using Weighted Data. (N=183)*

Variable	*B*	*SE B*	*β*	*R*	R^2	ΔR^2
Step 1				.471	.222	.222
Proj_Supr	.729	.101	.471	---	---	---
Step 2				.504	.254	.032
Proj_Supr	.615	.107	.398	---	---	---
Admin_Supr2	.239	.086	.193	---	---	---
Step 3				.545	.297	.043
Proj_Supr	.524	.108	.339	---	---	---
Admin_Supr2	.181	.086	.146	---	---	---
Benrwds	.283	.085	.225	---	---	---

Note: Run using weighted data

The second regression run using the OCQ_Motivation scale resulted in an R^2 of .297 indicating that nearly 30% of the variability of this scale was accounted for by project supervisor, administrative supervisor, and benefits and rewards. The other demographic group of interest in this study, in addition to race and sex, was age. The final step of the Mot_Scale regression revealed that the African American engineers and female engineers were not significant predictors; however, age was a significant contributor in predicting motivation.

Therefore, I chose to investigate age further by creating dummy variables for two age groups: under 39 years old and over 40 years old. Recall that the sample size was normally distributed

around the age group of 40 to 49, so I used this as a logical break point. The new dummy variables were: Age_under39 and Age_over40. Each age group was run separately in the regression calculation for each of the response variables using the weighted samples. The regression results using the Mot_Scale as the dependent variable for Age_under39 (*B* = -.536) had an overall R^2 of .403, for Age_over40 (*B* = .543) with R^2 of .419. Age_under39 and Age_over40 were not statistically significant predictors of the OCQ_Mot scale. Since the over-40 age group had a statistically significant positive influence on the Mot_Scale, I conducted further investigation and found that over- 60 years old strongly influenced motivation with a *B* coefficient of .797 for the Mot_Scale and .947 for the OCQ_Motivation scale. This age group was significant in predicting the Mot_Scale and the OCQ_Mot scale. It should be noted that younger age group (39 and under) revealed a negative value for the *B* coefficient, indicating that this group was significantly less motivated then the over- 40 age group and the 60 and over age group. The independent t-test indicates that there is not a significant difference between the means of each of the two demographic groups (African American males and females) and the full sample.

Summary

The survey instrument had 260 respondents of whom 238 provided usable data. The demographic representation in the sample was close to the population, however, weighting of the responses was necessary to ensure the small numbers of African Americans and females were significant in the regression outputs. The descriptive statistics indicated the data were normally distributed with the exception of a few variables that exhibited some skewness and high kurtosis. The reliability analysis showed that all the scales had a Chronbach alpha of greater than .70 (the minimum for this study) and they were consistent with the values used in previous studies according to Fields (2002). The factor analysis reduced 87 variables down to ten variables that

were used in the multiple regression analysis. There were two response variables: the motivation scale of 1 to 7 and the OCQ_Motivation scale ($r = .40$, $p < .01$). The regression analysis was run separately for each response variable. The regression analysis was run in a hierarchical manner, using block- by- block in a stepwise approach. The results of the first regression run using the motivation scale of 1 to 7, with demographic variables RaceDum_AA, Sex_Female, and Age revealed a cumulative R^2 of .415. The second regression run using the OCQ_Motivation scale revealed a cumulative R^2 of .297, indicating that 29.7% of the variability of this scale was accounted for by project supervisor, administrative supervisor, benefits, and rewards. The regression analysis revealed that female engineers did not contribute to predicting motivation for either scale. The regression analysis revealed that certain ages were significant contributors to predicting motivation. For engineers under 39 years old, their *B* coefficient was negative indicating they had a negative correlation to motivation. Ages of 40 years and older positively correlated to motivation. T-tests revealed that difference in the means between African American male engineers and the sample population was not significant, and this held true for the female engineers as well.

Chapter VI: Discussion

This chapter summarizes and discusses the significant study findings, the study's limitations, implications regarding management's role in the motivation of engineers at NASA Goddard, and recommendations for further research.

Summary of the Study

The purpose of this study was to identify predictors of engineers' levels of motivation at NASA Goddard Space Flight Center. Goddard has undergone a number of policy and budget changes, and a class action lawsuit settlement over the past five years that have had an impact on the workforce. NASA has not conducted any quantitative surveys to assess the workforce culture since 2001. The NASA name and its vibrant history have drawn many young people into the science and engineering field. The retention rate is also high for engineers--the mean number of years of experience is 20.3. The nature of the work and Goddard's mission to answer fundamental questions about the universe, solar system, and planet earth are strong intrinsic motivators for engineers to perform at their best. This study sought answers to the following questions:

1. What is the relative influence of demographic factors on the motivation of NASA engineers?
2. What specifically is the influence of supervisor behaviors on motivation of supervisor behaviors?
3. How do intrinsic and extrinsic factor influence motivation levels?

There were several assumptions that this study investigated. The first assumption was that NASA's mission serves as the *"Gestalt"* that galvanizes and motivates the engineering workforce. Engineers are highly internally motivated internally and, place high value on the quality of work that they do and have a sense of efficacy about their work, and have a high

degree of loyalty. This was based on the results of previous culture surveys at Goddard (NASA, 1999, 2003). The second assumption was that budget and policy changes, such as i.e. "full -cost accounting" (NASA, 1999, 2005), reduced the high level of motivation among the engineers. The third assumption was that African Americans and female engineers played a significant role in predicting the overall motivation of engineers, and that age was also a factor such that older engineers were less motivated because their skills were not current, and they were not open to updating their skills (Arvey & Neel, 1976). The fourth assumption was that the matrix management structure, which creates two supervisors: a project and an administrative, may affects engineers' motivation differently. The last assumption was that intrinsic factors would influence motivation more than extrinsic factors.

There were four predictor factors: demographic (race, gender, and age), supervisor behaviors, intrinsic, and extrinsic factors. A total of five scales taken from Fields (2002) were combined to create the questions used in the web- based survey instrument. Four scales were used to measure the predictor variables: they were the Job Satisfactions Scale (JSS) developed by Spector (1985), Satisfaction With My Supervisor (SWMS) scale developed by Scarpello and Vandenberg (1987), Job Satisfaction Inventory (JCI) scale developed by Sims, et al. (1976), and Empowerment at Work Scale (EWS) developed by Spreitzer (1995). The JSS scale was used to measure the extrinsic factors, the SWMS scale was used to measure supervisor behaviors, the JCI and EWS measured intrinsic factors. A total of 260 engineers participated in the survey out of a population of 863, resulting in a 30% response rate. After an initial data screening, 238 respondents provided usable data for analysis. Descriptive statistics revealed that the responses were normally distributed with the exception of five variables: OCQ_Mot1, JCI_Autonomy1 and 2, and EWS_Competency1 and 2 that showed significant Kurtosis. Factor analysis was first applied to the OCQ scale, reducing the nine positively worded questions to five that related most

to organizational loyalty and pride. The mean score for this new factor was 4.7 on a scale of one to seven. The mean score for the motivation scale was 5.31 on a scale of one to seven. This implies that the respondents considered their motivation level to be somewhat different from their organizational loyalty and pride. This was further tested by running a correlation analysis of the motivation scale and the new OCQ factor called OCQ_Motivation. . The resulting correlation was .40 ($p < .01$, two-tailed) (see Table 5.6). This represents a moderate correlation theoretically, but not strong enough for how motivation was defined for this study.

To address these questions and assumptions, a multiple regression analysis was used. The response or dependent variable of the study was motivation. Two different scales were used to measure the overall motivation level. The first scale, named Mot_Scale, was a rating from one to seven and was designed as a self- rating by the respondents. This scale had an overall median score of 6, and a mean score of 5.31. The second motivation scale, named OCQ_Motivation, was the Organization Commitment Questionnaire (OCQ) developed by Mowday, et al. (1979). This scale is a seven-point Likert and was chosen because of its broad use in many types of organizations, including technical organizations, and the questions related to organizational motivation factors. Its median score was 4.8 and the mean was 4.7. The Mot_Scale median score was fairly high and was consistent with the past culture surveys supported the first assumption that engineers' motivation was high. The median score was not as high for the OCQ_Motivation scale's (which measured organization loyalty and pride). Factor analysis reduced the OCQ scale down to these items which comprised the OCQ_Motivation scale: "talk up organization to friends very positively", "would accept almost any job to stay with this organization", "my values and organization values are similar", "proud to tell others I am part of this organization", and "this organization inspires my very best performance". This scale also addresses the premise in the first assumption that NASA's mission serves as a "Gestalt" that galvanizes the workforce,

which I argue contributes to organizational loyalty and pride. Previous studies that focused on engineers (Andrew & Farris, 1972; Badawy, 1988; Katz, 2004; Kopelman, 1977; Zengar & Lazzarini, 2004) did not consider this "Gestalt" effect which is a significant premise in this study. Similarly, Herzberg's, et al. (1959) work on motivators and hygiene factors considered the "work itself" to be a motivating factor.

The second assumption addressed policy and administrative procedures' effects on motivation. The results of the regression analysis revealed that policy was not a significant influence in predicting engineers' level of motivation or affecting their loyalty and pride. The reason for this is most likely due to the timing of this study. Policies like full-cost accounting have been in place for approximately five years and it is reasonable to assume that the engineers have adjusted to this policy. I argue that if this study had been conducted when the policy was first implemented, the results would most likely reveal policy to be a significant predictor of motivation. There were some open-ended responses that raised the issue of administrative burdens taking too much of the engineers' time, such as getting an expired network password updated.

The third assumption related to race as a predictor of engineers' motivation and level of loyalty and pride. This assumption is still unproven because the response rate of 32 out of 52 sampled for African Americans, significantly reduced statistical power. Regarding gender, there was a near equal number of female respondents versus male respondents (n = 100 female and n = 138 male, unweighted). However, the regression analysis revealed that sex was not a statistically significant factor in predicting motivation because "female" was removed in the first step of both regression runs. This is a significant finding, implying that an engineer's gender does not predict one's level of motivation in comparison to other factors. Regarding age, the regression analysis revealed that age was a significant predictor of motivation for both scales. A closer examination

of age was conducted by creating dummy variables for the different age groups. An interesting result was that the age group of 39 years old and younger had a negative *B* coefficient indicating a suppressor effect. The age of 40 and over positively influenced motivation, and the age of over 60 strongly influenced motivation with a *B* coefficient of .797 for the Mot_Scale and .947 for the OCQ_Motivation scale. The over-60 age group, with a mean of 37.6 years of experience, was the only one that influenced the OCQ_Motivation scale, which primarily measured organization loyalty and pride. This particular age group is near retirement, and the fact that they are still contributing to the NASA mission indicates that they are highly motivated and possess a lot of loyalty and pride toward their organization. This is contrary to my assumption that the older employees would have lower motivation because of outdated skills. My explanation for their motivation, loyalty, and pride is because the older engineers possess high competence through years of experience and lessons learned in working on a number of different projects. Arvey and Neel (1976) and Katz (2004) support this explanation in their findings that skill variety and jobs that make use of older engineers' abilities serve as motivators. Older engineers may also be driven by a desire to leave a legacy by mentoring younger engineers. The under-40 age group is less motivated relative to the over- 40 age group. Possible explanations could be based on their lack of project experience across multiple projects, which, in turn, reduces their ability to have as much influence on their project teams and in their organizations as the older, more experienced engineers.

The fourth assumption related to supervisor behaviors in a matrix management type organization such as the engineering directorate at NASA Goddard. The SWMS scale was used to measure supervisor satisfaction based on items such as their supervisor listening ability, supportiveness, advocacy, feedback provided, and technical expertise. Goddard uses a matrix management structure so that the majority of the engineers (183) reported to both a project

supervisor and an administrative supervisor from their home organization. The regression results revealed that the position of project supervisor was a stronger predictor of both motivation scales than was administrative supervisor. The administrative supervisor was less of a significant factor in the Mot_Scale, and was not a significant factor in the OCQ_Motivation scale using weighted data. This is no surprise in that in most cases, the engineers interact with their project supervisors on a daily basis and the quality of this relationship is a significant factor in an engineer's motivation level, and loyalty, and pride in the organization. I suggest that the day- to- day interaction with the project supervisor, which includes feedback on how well engineers are performing their jobs, carries more weight than the occasional interaction with their administrative supervisors. Also, it is typically the project supervisor who advocates on behalf of the engineer for rewards, recognition, and promotions. The project supervisor provides the primary input for performance reviews, although the administrative supervisor conducts the performance review. The interaction between administrative supervisor and the engineer occurs on an infrequent basis, usually during performance reviews and branch meetings. It is reasonable to conclude that the engineer's overall loyalty and pride in the organization would include the administrative supervisor relationship, but their level of motivation is more determined by the day-to-day interaction with the project supervisor.

The final assumption considered the effect of intrinsic and extrinsic factors with the premise that intrinsic factors would have more predictive ability than extrinsic factors. Intrinsic factors are those internal drivers that compel an individual to perform at high levels. According to Deci (1975) the primary components related to intrinsic motivation are autonomy, feedback, and competence. The JCI and EWS scales were used to measure intrinsic motivation. The results indicated that feedback and competence (B = .192 and B = .276, respectively), were significant contributors to the Mot_Scale only, but not autonomy (B = .087 for, Mot_Scale and B = .013

for, OCQ_Motivation). Finding that NASA Goddard's engineers are more motivated when they receive feedback on how well they are performing in their jobs and that they are more motivated when they feel competent is not surprising; but the absence of autonomy as a predictor contradicts the findings of Badawy (1988), Kantor (1997), Katz (2004), Kopelman (1977), and Schein (1999). The simple correlation of autonomy and Mot_Scale was .265. Even though an independent correlation exists, autonomy does not appear to add much predictive power once all the other variables were taken into account. However, the amount of feedback and the level of competence felt by the engineers as it relates to the project supervisor relationship dyad, supersedes any effects of autonomy. None of the intrinsic factors contributed to the OCQ_Motivation scale indicating that loyalty and pride were not influenced by autonomy, feedback, or competence. I would argue that both the project and administrative supervisor relationships are the dominant influencers of feelings of loyalty and pride held by the engineers.

The extrinsic factors were the final variables considered. They were promotion, benefits/rewards, and policy. These were measured using Spector's (1997) JSS scale with two additional policy questions that were specific to Goddard. All demographic groups, with the exception of the 60 and over age group, had benefits and rewards as the only extrinsic factor that contributed to predicting motivation for both scales. This factor considered items such as recognition for work, appreciation for their work, and rewards for work. These elements were found to be important for engineers' motivation (Badawy, 1988; Kopelman, 1977; Zenger & Lazzarini, 2004). Often, engineers at NASA Goddard have expressed dissatisfaction with not having opportunities to get promoted to the upper grades of GS-14 and 15. Their main desire to get promoted is not necessarily because they need the pay increase, but promotions serve as an acknowledgement that their contribution to the mission of NASA has been recognized and rewarded through a promotion to the next higher grade level. Promotions at NASA are primarily

based on positions that are competitively selected versus private industry where one can be promoted based on meritorious performance or if the position experiences an increase in responsibilities. Surprisingly, the 60 and over age group had promotion as a significant factor predicting the OCQ_Motivation scale representing loyalty and pride. An explanation for this could be that this age group, having worked an average of 37 years, may have received many rewards and recognition for past work, and those things have become less important over the years. In addition, it is possible that the over- 60 age group may not have succeeded in getting selected to senior management positions given the years that they have worked, thus being promoted to the highest technical level (GS-15 grade level) could be an important factor for them.

Study Limitations

There were some limitations associated with conducting this study. The method of data collection (using a web-based survey) was an efficient way of distributing the survey to a large population. However, using the web-based survey could have posed a limitation in that many respondents did not take the survey because they ignored the email request, or they were too busy, or they were inundated with emails. There may have also been cases of distrust on the part of engineers regarding anonymity and how the data would be used (Mowday, et al., 1979). The sample size of the demographic groups was proportional to the population demographic percentages; however, over-sampling of African Americans did not result in high enough sample numbers to yield significant results. The white race sample size overwhelmed the nonwhite sample size by a 5:1 ratio and the weighting of the data did not affect the results significantly. Another limitation was the wording of some of the negatively worded scale questions that caused some confusion with the respondents as indicated by some skewness and kurtosis associated with those questions. Also, organizational affiliation was not clear to some of the respondents, both of

the two previous limitations were themes revealed in comments from the pilot study and also the main study (see Appendix G).

The quantitative method used for this study provided empirical evidence about factors that can predict engineers' level of motivation. However, quantitative approaches do not answer the "*why*" question. Interviews and focus groups are very effective at informing quantitative data as to what underlying implications exist. This study did capture the opinions of the respondents using open- ended questions (found in Appendix G), which can inform the data in a limited way. However, use of a mixed method approach that included interviews and dialogue using qualitative methods such as naturalistic inquiry would have more fully informed the study results. A mixed method however was beyond the scope of this study.

Implications for NASA Management

What do the results of this study mean for NASA's leadership? From a demographic perspective, due to the low response rate for African Americans, the assumption that race was significant in predicting motivation is still unproven; however, management is cautioned not to ignore the concerns and issues raised by minority groups. Likewise for the female engineers, whose response rate was high enough for the regression analysis, but did not significantly contribute to predicting motivation in the results. The diversity programs at Goddard have had a positive impact and they should continue to get management support. The demographic factor that does make a difference is age. The results of the study indicated less of an influence from the under- 39 years old age group. Goddard's leadership should pay particular attention to this age group as it represents the future of our center. Initiatives that increase ways of acknowledging, showing appreciation, and rewarding younger employees for their contribution without having to wait until they have had 20 or more years of experience would most likely increase their level of motivation. The engineers over 60 years old are the most motivated age

group, and management must tap into this valuable resource whenever possible to meet our mission objectives. One such role for this age group is the mentoring of and partnering with the younger engineers by passing on their experiences and lessons learned, and advocating on their behalf for more challenging and rewarding job roles with increased responsibility. Adult learning theorists emphasize the connectedness of our individual experiences being bound together (Mezirow, 2000)), and that learning establishes inclusion and engenders competence (Wlodkowski, 1999). Older engineers' serving as mentors plays a key role in passing on corporate knowledge to the new generation of engineers.

NASA management must continue to foster technical learning communities as a method of increasing engineer motivation. NASA leadership must leverage the unique role that the project team leaders and project managers play in affecting the motivation of engineers. Their role is much broader than just meeting the project schedule, costs, and mission requirements. They are the individuals that engineers come in contact with the most on a day- to- day basis in a matrix organization. A project leader's role is critical in maintaining a highly motivated and productive workforce. Goddard's senior leadership, along with the Office of Human Capital Management, must continually support project leaders by equipping them with the necessary technical and leadership skills through continuous training and development that is vital for our engineering workforce.

Further Study

Additional inquiry could provide more meaning for the data. It is my desire to convene focus groups with the engineers, specifically the under 39- years-old group, to get their perspective on what it means that their age group is less motivated than older engineers. I would like to meet with supervisors and OHCM managers as well to get their perspectives on this research. Another area for study is to use the survey instrument and methodology applied to

other professions such as scientists and technicians/wage grade employees; the administrative professions such as secretaries, procurement, and accounting specialists; and NASA engineering contractors in the private sector. The data set that I have with 238 cases is a valuable resource and more analyses can be conducted with the data. Regressions can be run separately for the project supervisors versus the administrative supervisors. Years of experience and education level can also be explored as a factor influencing motivation. I would like to rerun the survey targeted at African Americans to get a higher response rate. I could also further explore different weightings on the data to better account for over- sampling African Americans.

Concluding Remarks

This study represents a culmination of my Ph.D. journey at Antioch. I recall over six years ago in my application essay stating that my area of interest was human behavior and work place diversity in a technical organization. Through the course of my journey, that interest turned into deep passion. My passion to learn and investigate motivated my voice to emerge in an intellectual and scholarly way. This experience has stretched and challenged me beyond what I ever could have imagined, and the experience has also been intense at times; I have felt exhilaration and defeat. At times, it felt like taking two steps forward and three steps back. Overall, it has been very rewarding and the feelings of competence, self-efficacy, and self-actualization I experienced serves as a testament to every aspect of the PhD in Leadership and Change program at Antioch. . If anyone were to ask me what it takes to complete a PhD, I would share with them my five “P’s”: Passion, Process, Patience, Perseverance, and People.

APPENDIX

Appendix A

Survey Instrument

INTRODUCTION

The purpose of this survey is to investigate factors that influence the motivation of engineers working in the Applied Engineering and Technology Directorate (AETD) at NASA Goddard.

This survey is being conducted by Howard Kea, Leadership Development and Culture Change Office, Code 111 in partial fulfillment of his PhD requirements at Antioch University.

The aggregate results of the survey will be shared with the Office of Human Capital Management (OHCM), Code 110, AETD Management, Code 500 and any other interested parties. The results will be available for use by the OHCM and AETD to improve leadership development and other training programs to increase the effectiveness of Goddard's engineering workforce. The survey takes approximately 15 minutes to complete.

All measures to ensure strict confidentiality and anonymity in protecting your privacy will be used. Your support is greatly appreciated.

If you have any questions regarding the survey please contact Howard Kea at: 301 442-8230 or email: Howard.E.Kea@nasa.gov

CURRENT LEVEL OF MOTIVATION

This first set of questions is designed to assess your current level of work motivation, organizational commitment and work attitude relative to AETD as the organization. Please answer each question based on your current work situation.

1. On a scale from 1 to 7 what is your current overall level of motivation at work, with 1 being very low and 7 being very high?

	1	2	3	4	5	6	7
Rate Overall Motivation	☐	☐	☐	☐	☐	☐	☐

2. I am willing to put in a great deal of effort beyond that normally expected in order to help this organization be successful.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	☐	☐	☐	☐	☐	☐	☐

3. I talk up this organization to my friends as a great organization to work for.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	☐	☐	☐	☐	☐	☐	☐

4. I feel very little loyalty to this organization.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	☐	☐	☐	☐	☐	☐	☐

5. I would accept almost any type of job assignment in order to keep working for this organization.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	□	□	□	□	□	□	□

6. I find that my values and the organization's values are very similar.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	□	□	□	□	□	□	□

7. I am proud to tell others that I am part of this organization.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	□	□	□	□	□	□	□

8. I could just as well be working for a different organization as long as the type of work was similar.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	□	□	□	□	□	□	□

9. This organization really inspires the very best in me in the way of job performance.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	□	□	□	□	□	□	□

10. It would take very little change in my present circumstance to cause me to leave this organization.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	□	□	□	□	□	□	□

11. I am extremely glad that I chose this organization to work for over others I was considering at the time I joined.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	□	□	□	□	□	□	□

12. There's not too much to be gained by sticking with this organization indefinitely.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	□	□	□	□	□	□	□

13. Often, I find it difficult to agree with this organization's policies on important matters relating to its employees.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	□	□	□	□	□	□	□

14. I really care about the fate of this organization.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	□	□	□	□	□	□	□

15. For me, this is the best of all possible organizations for which to work.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	□	□	□	□	□	□	□

16. Deciding to work for this organization was not a mistake on my part.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree or Agree	Slightly Agree	Moderately Agree	Strongly Agree
Choose One	□	□	□	□	□	□	□

17. What, if any other, factors affect your motivation in your current work situation?

_____
_____
_____
_____

SUPERVISOR BEHAVIOR FACTORS

18. Do you currently report to a TECHNICAL LEAD, PROJECT LEAD or PROJECT MANAGER?

Yes □
No □

TECHNICAL/ PROJECT LEAD

19. Now thinking about your TECHNICAL LEAD, PROJECT LEAD or PROJECT MANAGER, carefully read each statement and indicate how satisfied or dissatisfied you are with the way your supervisor behaves toward you.

	Very Dissatisfied	Dissatisfied	Neither Satisfied nor Dissatisfied	Satisfied	Very Satisfied
1. The way my supervisor listens when I have something important to say.	□	□	□	□	□
2. The way my supervisor sets clear work goals.	□	□	□	□	□
3. The way my supervisor treats me when I make a mistake.	□	□	□	□	□
4. The way my supervisor is consistent in his/her behavior toward subordinates.	□	□	□	□	□
5. The way my supervisor helps me to get the job done.	□	□	□	□	□
6. The way my supervisor gives me credit for my ideas.	□	□	□	□	□
7. The way my supervisor gives me clear instruction.	□	□	□	□	□
8. The way my supervisor informs me about work changes ahead of time.	□	□	□	□	□
9. The way my supervisor follows through to get problems solved.	□	□	□	□	□
10. The way my supervisor understands the problems I might run into doing the job.	□	□	□	□	□

11. The way my supervisor shows concern for my career progress.	□	□	□	□	□

20. Now still thinking about your TECHNICAL LEAD, PROJECT LEAD or PROJECT MANAGER, carefully read each statement and indicate how satisfied or dissatisfied you are with the way your supervisor behaves toward you.

	Very Dissatisfied	Dissatisfied	Neither Satisfied nor Dissatisfied	Satisfied	Very Satisfied
1. My supervisor's backing me up with other management.	□	□	□	□	□
2. The frequency with which I get a pat on the back for doing a good job.	□	□	□	□	□
3. The technical competence of my supervisor.					
The amount of time I get to work on a task before I am moved to another task.	□	□	□	□	□
4. The time I have to do the job right.	□	□	□	□	□
5. The way my job responsibilities are clearly defined.	□	□	□	□	□

21. What, if any other, TECHNICAL/PROJECT SUPERVISOR behaviors affect your motivation in your current work situation?

_____

_____

_____

_____

ADMINISTRATIVE SUPERVISOR / BRANCH HEAD

22. Do you currently report to an ADMINISTRATIVE SUPERVISOR/BRANCH HEAD who is not your technical or project supervisor?

Yes □
No □

23. Now thinking about your ADMINISTRATIVE SUPERVISOR/BRANCH HEAD, etc. carefully read each statement and indicate how satisfied or dissatisfied you are with the way your supervisor behaves toward you.

	Very Dissatisfied	Dissatisfied	Neither Satisfied nor Dissatisfied	Satisfied	Very Satisfied
1. The way my supervisor listens when I have something important to say.	□	□	□	□	□
2. The way my supervisor sets clear work goals.	□	□	□	□	□
3. The way my supervisor treats me when I make a mistake.	□	□	□	□	□
4. The way my supervisor is consistent in his/her behavior toward subordinates.	□	□	□	□	□
5. The way my supervisor helps me to get the job done.	□	□	□	□	□
6. The way my supervisor gives me credit for my ideas.	□	□	□	□	□
7. The way my supervisor gives me clear instruction.	□	□	□	□	□
8. The way my supervisor informs me about work changes ahead of time.	□	□	□	□	□
9. The way my supervisor follows through to get problems solved.	□	□	□	□	□
10. The way my supervisor understands the problems I might run into doing the job.	□	□	□	□	□
11. The way my supervisor shows concern for my career progress.	□	□	□	□	□

24. Now still thinking about your ADMINISTRATIVE SUPERVISOR/BRANCH HEAD, etc. carefully read each statement and indicate how satisfied or dissatisfied you are with the way your supervisor behaves toward you.

	Very Dissatisfied	Dissatisfied	Neither Satisfied nor Dissatisfied	Satisfied	Very Satisfied
1. My supervisor's backing me up with other management.	□	□	□	□	□
2. The frequency with which I get a pat on the back for doing a good job.	□	□	□	□	□
3. The technical competence of my supervisor.	□	□	□	□	□
4. The amount of time I get to work on a task before I am moved to another task.	□	□	□	□	□
5. The time I have to do the job right.	□	□	□	□	□
6. The way my job responsibilities are clearly defined.	□	□	□	□	□

25. What, if any other, ADMINISTRATIVE SUPERVISOR behaviors affect your motivation in your current work situation?

_____

_____

_____

_____

INTRINSIC FACTORS

26. Now thinking about how much autonomy you feel in performing your job, please indicate on a scale of 1 to 5, with 1 being very little and 5 being very much.

	1----Very much	2	3	4	5----very little
How much you are left on your own to do your own work?	□	□	□	□	□
To what extent are you able to act independently of your supervisor in performing your job function?	□	□	□	□	□
To what extent are you able to do your job independently of others?	□	□	□	□	□

27. Now still thinking about the amount of autonomy you feel in performing your job, please indicate on a scale of 1 to 5, with 1 being minimum amount and 5 being maximum amount.

	1 minimum amount	2	3	4	5 maximum amount
The freedom to do pretty much what I want on my job.	□	□	□	□	□
The opportunity for independent thought and action.	□	□	□	□	□
The control I have over the pace of my work.	□	□	□	□	□

28. Now thinking about how much feedback you get on how well you are performing your job, please indicate on a scale from 1 to 5, with 1 being very little and 5 being very much.

	1----Very much	2	3	4	5----very little
To what extent do you find out how well you are doing on the job as you are working?	□	□	□	□	□
To what extent do you receive information from your					

supervisor on your job performance?	□	□	□	□	□

29. Now still thinking about the amount of feedback you get on how well you are performing your job, please indicate on a scale from 1 to 5, with 1 being minimum amount and 5 being maximum amount.

	1 minimum amount	2	3	4	5 maximum amount
The feedback from my supervisor on how well I'm doing.	□	□	□	□	□
The opportunity to find out how well I am doing on my job.	□	□	□	□	□
The feeling that I know whether I am performing my job well or poorly.	□	□	□	□	□

30. Now thinking about how competent you feel in performing your job, how strongly do you disagree or agree with the following statements?

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Disagree nor Agree	Slightly Agree	Moderately Agree	Strongly Agree
I am confident about my ability to do my job.	□	□	□	□	□	□	□
I am self-assured about my capabilities to perform my work activities.	□	□	□	□	□	□	□
I have mastered the skills Necessary for my job.	□	□	□	□	□	□	□

31. What, if any other, intrinsic factors affect your motivation in your current work situation?

_____

_____

_____

_____

EXTRINSIC FACTORS

32. Now thinking about how satisfied you are with pay and promotion, how much do you disagree or agree with the following statements?

	Disagree very much	Disagree Moderately	Disagree Slightly	Agree Slightly	Agree Moderately much	Agree Very
I feel I am being paid a fair amount for the work I do.	□	□	□	□	□	□
Raises are too few and far between.	□	□	□	□	□	□
I am unappreciated by the organization when I think about what they pay me.	□	□	□	□	□	□
I feel satisfied with my chances for salary increases.	□	□	□	□	□	□
There is really too little chance for promotion on my job.	□	□	□	□	□	□
Those who do well on the job stand a fair chance of being promoted.	□	□	□	□	□	□
People get ahead as fast here as they do in other						

places.	□	□	□	□	□	□
I am satisfied with my chances for promotion.	□	□	□	□	□	□

33. Now thinking about how satisfied you are with benefits and rewards, how much do you disagree or agree with the following statements?

	Disagree very much	Disagree Moderately	Disagree Slightly	Agree Slightly	Agree Moderately much	Agree Very
I am not satisfied with the benefits I receive.	□	□	□	□	□	□
The benefits we receive are as good as most other organizations offer.	□	□	□	□	□	□
The benefit package we have is equitable.						
When I do a good job, I receive the recognition for it that I should receive.	□	□	□	□	□	□
I do not feel that the work I do is appreciated.	□	□	□	□	□	□
There are few rewards for those who work here.	□	□	□	□	□	□
I don't feel my efforts are rewarded the way they should be.	□	□	□	□	□	□

34. Now thinking about how satisfied you are with operating policies and procedures, how much do you disagree or agree with the following statements?

	Disagree very much	Disagree Moderately	Disagree Slightly	Agree Slightly	Agree Moderately much	Agree Very
Many of our rules and procedures make doing a good job difficult.	□	□	□	□	□	□
My efforts to do a good job are seldom blocked by red tape.	□	□	□	□	□	□
I have too much to do at work.	□	□	□	□	□	□
I have too much paperwork.	□	□	□	□	□	□
The accounting procedures take too much of my time.	□	□	□	□	□	□
Administrative processes interfere with my technical work.	□	□	□	□	□	□

35. What, if any other, extrinsic factors affect your motivation in your current work situation?

_____
_____
_____
_____

36. What is your engineering discipline?

_____
_____
_____

37. Indicate your age category?

□ Under 30
□ 30 - 39
□ 40 - 49
□ 50 - 59
□ 60 - 69
□ Over 70

38. What is your total years of engineering experience? _____

39. Please indicate your gender?

- Male
- Female

40. What racial group are you identified with?

- White/Caucasian
- Black/African American
- Native American
- Hispanic
- Asian/Pacific Islander

Other (please specify) _____

41. What is the highest Degree you have earned?

- High School Diploma
- Bachelors
- Masters
- PhD

Other (please specify) _____

COMMENTS AND FEEDBACK

I would like to get your feedback on the survey instrument. What were your thoughts, regarding the length, clarity of instructions, appropriateness for AETD engineers, web access or other helpful feedback?

Thank you for completing the survey and helping me with my research.
Howard Kea

42. Feedback & Comments

_____
_____
_____
_____
_____
_____
_____
_____
_____

Appendix B

NASA Letters of Approval

Professor Jon Wergin, Committee Chair,
PhD in Leadership and Change Program
Antioch University

Dear Professor Wergin:

This letter is to acknowledge that I have been briefed and approve Howard Kea's area of research investigating the factors that influence the motivation level of engineers working in the Applied Engineering and Technology Directorate at NASA Goddard Space Flight Center.

I look forward to seeing the results of Howard's research, and using it to improve the performance of our engineering personnel in meeting our Center's mission goals and objectives.

Sincerely,

Verron Brade, Director
Office of Human Capital Management

Professor Jon Wergin, Committee Chair,
PhD in Leadership and Change Program
Antioch University

Dear Professor Wergin:

This letter is to acknowledge that I have been briefed and approve Howard Kea's area of research investigating the factors that influence the motivation level of engineers working in the Applied Engineering and Technology Directorate at NASA Goddard Space Flight Center.

I look forward to seeing the results of Howard's research, and using it to improve the performance of our engineering personnel in meeting our Center's mission goals and objectives.

Sincerely,

Orlando Figueroa, Director
Applied Engineering and Technology Directorate

Appendix C

IRB Approval Form

1. Name and mailing address of Principal Investigator(s):
Howard E Kea
11612 Grandview Ave.

Silver Spring, MD 20902

For Faculty - Other Principal Investigator:
2. Departmental Status: Student

3. Phone Number: (a) Work (301) 286-0464 (b) Home (301) 588-2663

4. Name of Core Faculty Advisor: Jon Wergin

5. Name & Contact Information of other Program Faculty Involved in this Project:

a Antioch Faculty and/or Primary Evaluator for Learning Achievement or Research Project: Jon Wergin

E-mail address of non-PhD faculty person:

Note to students: Please have your primary evaluator send an email to Dr. Carolyn Kenny indicating his/her approval of your research proposal.

b. If this ethics application is for your dissertation, the name of your Dissertation Chair appears below.

Jon Wergin

6. Learning Achievement
Title of Project: HOW ARE NASA ENGINEERS MOTIVATED? AN ANALYSIS OF FACTORS THAT AFFECT NASA GODDARD ENGINEERS? LEVEL OF MOTIVATION

7. Source of Funding for the project (if applicable):

8. Expected starting date for project: 03/15/2008

9. Anticipated completion date for data collection: 04/01/2008

10. Describe the proposed participants- age, number, sex, race, or other special characteristics. (Up to 250 words):
Participants are engineers working at the NASA Goddard Space Flight Center in Greenbelt, MD. They range in age from 22 to 75. They cover both sexes male and female. The following races will be represented in the sample: Caucasian, African American, Hispanic, Asian/Pacific Islander and Native American. The total population is approximately 1000. I plan to sample at

least half of the population using a stratified random sampling method. The strata will be based on race and will be sampled at different rates.

11. Describe how the participants are to be selected and recruited. (Up to 400 words):
I plan to sample at least half of the population using a stratified random sampling method. The strata will be based on race and will be sampled at different rates.

12. Describe the proposed procedures, e.g., interviewing survey questionnaires, experiments, etc. in the project. Any proposed experimental activities that are included in evaluation, research, development, demonstration, instruction, study, treatments, debriefing, questionnaires, and similar projects must be described. Continue your description on following page if necessary. USE SIMPLE LANGUAGE AND AVOID JARGON. Please do not insert a copy of your methodology section from your proposal. State briefly and concisely the procedures for the project. (500 words):
The primary instrument for collecting data will be an online survey, however hard copies of the survey will be provided for any participant uncomfortable with doing an online survey. The procedure will be that an email will go out to the designated strata in the population based on the predetermined sampling rates. No identifying information will be collected other than general demographic data. If the sampling amount for a particular stratum is not met, then a second request will go out to those specific strata that had low participation requesting their participation if they had not already done so. The survey will be password protected, and a different password will be used for each stratum, and if a second request for participation is required a new password will be created for that particular stratum.

13. Project Purpose(s) and Benefits: (400 words):
The purpose of the project is to investigate the following factors (predictor variables) that may positively or negatively influence the level of motivation of NASA Goddard engineers: Racial, i.e. African American engineers vs. non-African American engineers, Supervisor Behaviors, Intrinsic Factors and Extrinsic Factors.
The benefits would include the development of improved supervisor training and development programs and, also provide managers with key indicators that would allow them to facilitate the increase or sustaining of engineers' high level of motivation, thus contributing to higher performance.

14. If participants in this proposed research may thereby be exposed to an elevated possibility of harm—physiological, psychological, or social—please provide the following information: (UP to 500 words)

a. Identify and describe the possible benefits and risks.
NOTE: for international research or vulnerable populations, please provide information about local culture that will assist the review committee in evaluating potential risks to participants, particularly when the project raises issues related to power differentials:
Exposure to harm is very minimal or none at all.

14b. Explain why you believe the risks are so outweighed by the benefits described in (13) as to warrant asking participants to accept these risks. Include a discussion of why the research method you propose is superior to alternative methods that may entail less risk:

14c. Explain fully how the rights and welfare of participants at risk will be protected (e.g., screening out particularly vulnerable participants, follow-up contact with participants, etc.):
15. Explain how participants' privacy is addressed by your proposed research. Specify any steps taken to guard the anonymity of participants and/or confidentiality of their responses. Indicate what personal identifying information will be kept, and procedures for storage and ultimate disposal of personal information. (400 words):
This is an online survey, I will not be collecting personal information such as name, organization, SSN, employee ID number etc. I will be using Survey Monkey which also provides the additional protection of not tracking IP addresses of the participants. Since the survey will be conducted at a government facility using government computers, the NASA IT security office does have the capacity to monitor web sites visited and even monitor keystrokes. I will notify the NASA Goddard IT Security office of my project and provide them with the web address so that they will know it is an authorized site that participants will be visiting. In addition, NASA Goddard engineers are bargaining unit employees and are members of the Goddard Engineers, Scientists and Technicians Association (GESTA) Union. I am required to inform the Union representatives and allow them access to the survey as well.

16. Informed consent statements, if one is used, are to be included with this application. If information other than that provided on the informed consent form is provided (e.g. a cover letter), attach a copy of such information. To submit or fax these documents, refer to the instructions in the next question.

If a consent form is not used, or if consent is to be presented orally, state your reason for this modification below:
An informed consent statement will be incorporated into the survey, the each participant will be required to read it and acknowledge having read and understood it by clicking a confirmation.

17. If questionnaires, tests, or related research instruments are to be used, then you must submit a copy of the instrument, or a detailed description (with examples of items) of the research instruments, questionnaires, or tests that are to be used in the project.. Copies will be retained in the permanent IRB files. To submit documents
i Go to end of on-line form to upload attachments; or
ii. Fax to IRB Chair: Carolyn Kenny

Please identify all attached documents.
The web address of the final instrument will be provided. A preliminary version of the survey is at the following address:
Here is the link:
https://www.surveymonkey.com/s.aspx?sm=FC3OzoiUTy6YWl8plGirRQ_3d_3d
The password is: survey

18. Will electrical or mechanical devices be applied to participants? No

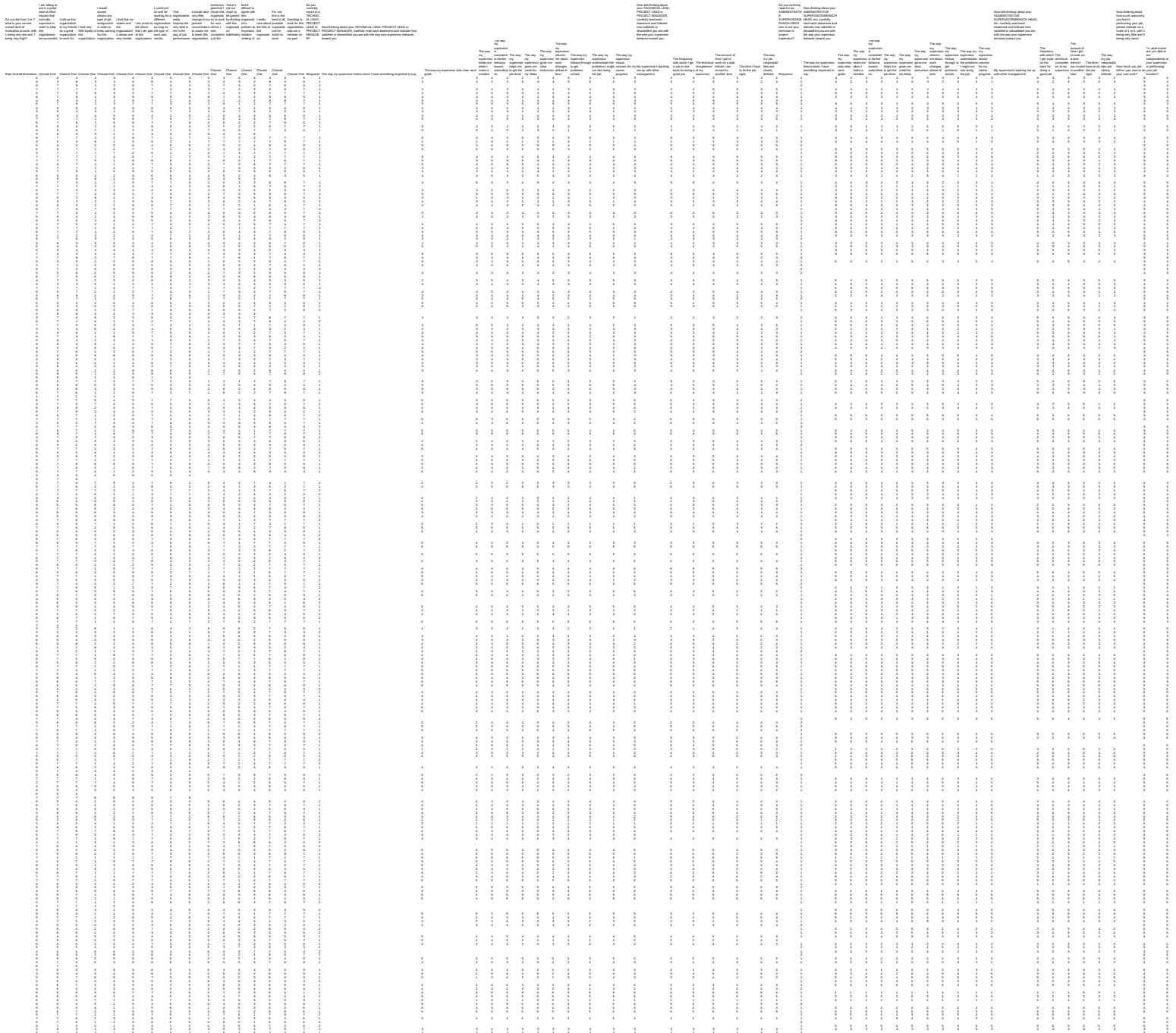
If YES, describe: No

I agree to conduct this project in accordance with Antioch University's policies and requirements

involving research.

Appendix D

Data Set



Appendix E

Open Ended Responses and Comments

What, if any other, factors affect your motivation in your current work situation?

1. I am very motivated by my job assignments. I like the chance to learn new things and I am motivated by the science associated with my mission. I am also motivated to work hard for the people on my project. I don't feel any loyalty to AETD and if a good opportunity at GSFC came up outside of AETD, I would take it.

2. Opportunities to interface with others across the center. There is minimal management directives.

3. Successful team member in a group that put together, tested and launched a working instrument.

4. The work that I am doing. I am matrixed and supporting an interesting flight program.

5. Lack of funding from HQ

6. Flexibility to pursue problems quickly that require attention, are a bit unusual, are perhaps questionable applicability in the near-term. Working on the human space program with JSC is a great inspiration.

7. Branch management technical competency and fairness Matrix Project leadership (immediate and PM/DPM) Competency of co-workers in branch and matrix Project

8. Pay

9. Factors that affect my motivation are: Recognition Appreciation non-discriminatory environment where I can contribute w/o pre-judgment Environment that is open and with out information control games

10. My loyalty lies with NASA, then GSFC, then a slight preference for AETD. Working as a matrixed employee, my motivation usually comes from the program I'm supporting. However, I really appreciate the technical independence that comes from working for AETD instead of code 400. I have worked for several different branches within AETD. I find that my personal relationship with branch management and their skills (or lack) as managers have a profound effect on my motivation and loyalty to AETD.

11. Parenthood-I do feel pressured from co-workers (not management) to put work before family and to be available at any moment. I don't like this trend and ultimately I don't think it is what is best for the organization.

12. Need more meaningful work to do

13. The Project (matrixed organization) is more of a factor in my motivation than the home (AETD) organization. My commitment to the Project is stronger and the extra effort, time commitment and weekend work is driven to make the Project a success, not really AETD.

14. Full cost accounting has been a total bust. It is costing considerably more money than the old way of doing business.

15. My fit within my branch also is discouraging to my motivation. It is not that the branch treats employees poorly, but that I don't believe I fit in the branch.

16. Enjoy the work, like the people I work with, support from management in resolving issues, advancement opportunity

17. Technology drives my motivation, not the organization. If the opportunity arose tomorrow offering an increase in technological pursuit and reducing the government imposed “Mickey Mouse”, I'd move on in a New York minute.

18. Our Branch Head is not very social. In my opinion, he keeps to himself too much. There is no mentoring in our branch.

19. Balancing life

20. Middle Management (Assoc. Branch Heads & Branch Heads) availability to discuss planning for employee careers. They always seem too busy to talk with us and hear us.

21. Peer recognition inside and outside the organization; success, recognition, and advancement for others on the projects I manage.

22. Self motivation. Motivation to deliver a quality product. The responsibility of delivering working flight hardware with no latent failures.

23. Work load, enjoyment level of the assignment, personal aspects - primarily school.

24. Diversity recognition could be improved. It should be real rather than based on a policy.

25. matrix assignment Leadership in matrix environment

26. Positively: regular praise and recognition from supervisors for a job well done or going above and beyond negatively: lack of respect from co-workers (e.g. as a young female, I get interrupted in meetings a lot), workload - too much on the plate

27. Having been through multiple reorganizations it's more about the work I do not the organization I'm in. As long as I enjoy and am challenged by my work and the organization doesn't make it harder to do that work I am happy.

28. Exterior forces are combining to make it more difficult to remain as focused on the efforts of Goddard. The balance between home and work has tilted due to life circumstances including deaths, elder-care issues, family Diaspora and personal aging.

29. I am motivated to do excellent work to my highest education and ability because I do my work for God and I expect to receive my rewards from God. However, I could be more motivated by more promotions, more recognition of work, more humane supervisors, and a lot less stress by having more telecommuting opportunities here at NASA.

30. Not having clear priorities and assignments with detailed expectations causes me to lose motivation. It is easier for me if there are lots of deadlines and goals involved, but sometimes my current work situation involves a lot of waiting and bottlenecks that seem to prevent productivity.

31. Being held to the same standards as my peers

32. To have a sense that those in the many layers of management above me care about the work I do.

33. This is an inflexible environment

34. Stupid time-wasting decisions like changing the email and ODIN. lack of resources to do the job correctly instead of doing it over.

35. lack of interesting and challenging work assignments -I don't feel like the organization is using my skills to their fullest potential.

36. Quality of the people I work for and with. Amount of impact I have on the final product.

37. I am motivated by the importance of the program I currently support to the agency and it's future.

38. It is important for me to continue my work because I don't like to let people down, the people that support my task are dedicated and hard working, and the work provides my paycheck.

39. The scientific objective of the project is a great motivator, but it so happens that recent personnel changes have compromised the work environment. This has a negative effect on the morale and motivation. Otherwise this remains a great project form the standpoint of the technical objectives and challenges.

40. Technical challenge, responsibility and ability to make a difference and contribution

41. Engineering integrity, management decisions, work conduct, misuse of personnel authority,

42. I like what I am doing and I feel privileged to be part of this organization. My dream was to be a NASA engineer, and at AETD I fulfilled that dream.

43. I think there are two parallel factors that really affect an employees performance here. These are commitment to the success of the organization and commitment to personal success. Overall, I think commitment to personal success, as well as maintaining a reputation as a knowledgeable and highly skilled individual is what drives me the most. However, different people have different motivational factors.

44. Doing Engineering, attending fewer meetings, filling out fewer status reports.

45. Good Line Supervisor, variety of duties

46. Weeding out non-performers and free loaders. We have too many of them.

47. Type of work -People I work with

48. Workload, training opportunities, management style.

49. Excellent support from branch Excellent project management and team

50. Inspired by my colleagues and engineers; revel in the technical creativity of coworkers (and hopefully myself too). Motivated by the space program and advances in astronomy. Servicing Mission to Hubble is quite a motivator.

51. Outside people almost equate NASA as technology innovator, yet NASA has put very little emphasis on technology development in the past few years. It is very scary to see that other countries are catching up on or surpassing us in many areas.

52. Bogging us down with ridiculous standards. Allowing non-performers to continue to drag down productivity.

53. Politization of funding by administration and/or headquarters Technical decisions being driven solely by cost or being decided by managers who do not comprehend the technical and therefore necessarily cost and schedule ramifications of their decisions. Establishment of programmatic performance metrics by non-technical persons who do not fully understand the complexities of the hardware we build and do not understand that each mission is usually unique and spending curves from past missions can not be blindly applied to new missions. Unrealistic budgeting by the administration: we cannot build a safe and worthy crew vehicle and continue with all that we have to do with minimal increases in overall NASA funding. I'd like to buy a new car without changing my personal budget but that is not going to happen. The result of trying to maintain this delusionary policy has been disastrous to many programs. The worst of which is the change in funding and contingency funding. Rightly or wrongly NASA's culture historically knows that when you bid X dollars the real cost is X + a contingency factor*X dollars. People would bid x and assume HQ was holding the contingency in reserve. Changing the rules in the middle of the game to require no overruns is causing all kinds of problems and resulting in under engineered programs that result in more expensive and more risk prone missions. We can pay the correct sum to build it right or pay many times that sum to fix it after we built it wrong. The same problem happens when money from programs in phase A is diverted to other programs in phase C or D. Critical phase A engineering is not done; the project is under engineered, and the result is even more costs then it would have otherwise required and increased risk of failure. Basically in engineering, you can pay me X now or pay me 10X or 100x later. If you don't spend the money when you need to spend it, it costs even more to recover later.

54. Team members job description schedule budget

55. Administrative work

56. Coworkers on current project. Ability to help and make a difference.

57. Pay and Benefits.

58. Type of work I am doing. Nothing to do with the organization.

59. Constant worry about funding and what I'll do next is a big de-motivator.

60. The motivation of the other employees. Their ability to work together as a team and the peer pressure that inevitably comes from not wanting to let someone down.

61. The attitudes and personalities of my coworkers.

62. Poor Leadership/Management/Communication Skills from all levels of management beginning with the Branch Heads and moving up. I think that the AETD Director has the right idea and is an amazing leader but somehow his passion ethics and morale does not trickle down. I don't even see it reflected at the division level or lower. This is why my motivation can be low at times and the only way I keep it high is to put as much space between the leadership and I as I possibly can, focus on my work, and network with others to find resources and advocate my interests. Unfortunately 80% of my fellow employees are severely unmotivated and most are seriously considering leaving especially some of the younger people but also people who have been here for 20 years. Most express feeling that there is nothing new to look forward to and that they are unappreciated - but most of all that nobody especially management cares or is willing to aid in their development. Instead of surveying the workers; a survey should be done on the motivation of the actual supervisors. Most of them are unmotivated, totally disconnected from the science and the NASA mission and focused on pushing paper . And it is this lack of motivation and appreciation for the big picture which spreads like a disease and creates workers that feel like unappreciated bitter orphans. I was excited when I first came to NASA, but it was in fact the older employees whom lacked ambition and energy who tried to dissuade me from being too active or having too much hope- they also talked down about the NASA mission

and the lack of support received from management. It was at this juncture that I knew I would have to act as a self sustaining island to maintain my sanity and work ethic here. So consequently, finding a mentor has been hard to do as one can imagine in this environment. I am motivated and I love what I do, but this is based on the ethics and drive that I brought with me from my previous research intensive environment - it is definitely not something that I would have or could develop based on the environment at GSFC. Oh and the best part is that everyone at GSFC tries to pretend that there is not a problem :-). 'Denial ain't just a river in Egypt!". I have hope for the future of GSFC but management needs a kick in the butt and serious energy booster shot and a lesson on emotional intelligence - in light of most corporate culture coming from the top.

63. The complete lack of employee recognition & awards. Several outstanding employees seem to never get any directorate or center level awards, or promotions. Having to write & submit your own promotions package seems very wrong to me, but is standard around here. There should be a wider awards & promotions system. Just a little recognition for outstanding work would go along way in keeping me motivated. It just doesn't happen.

64. Challenging work --one-of-a-kind engineering --great people --important, forward looking objectives

65. My motivation is affected by several factors. It is very important for me to be a part of a team that works together well, communicates, shares the load evenly, and maintains a positive attitude. I appreciate similar qualities in my branch management including being able to approach my management, knowing they will follow through on issues I may have, and having their support in furthering my career (training, work opportunities) regardless of whether my goals keep me in the branch or lead me elsewhere. My motivation is also greatly affected by my level of interest in the daily tasks I am expected to perform. For example, when I was asked to temporarily fill the role of a module lead (which very much interests me), I worked long hours - even weekends - to get things done correctly and on schedule. While it was hard work, I enjoyed myself and took pride in what we accomplished. On the other hand, when the temporary assignment was finished and I was asked to monitor mass properties (which do not greatly interest me) I noticed a sizable decrease in my motivation. I now had to push myself to get the tasks done. The job was less enjoyable and I started to consider possible changes that needed to be made.

66. People I work with

67. Being allowed to actually do my job.

68. Motivation low right now because project I work on is boring & not really within my area of expertise.

69. I believe that working in space is an important and useful thing for our country to be doing. 2. Some of the things I do are fun.

70. Interesting technical work or lack thereof

71. I was assigned to this work. I am totally unqualified. The engineers I work with are professional and are very tolerant of my questions. They want me to do a good job. Therefore, I like the people, the work is good, but this isn't work I chose. This is work that my supervisor gave me to do. It was either this or retire.

72. I love the fact that I am able to continue to learn and create new understanding in my field and life as a whole. The people in this organization are top notch. While this can be intimidating at times, I am glad that I can be part of this organization and learn as much as I can from these brilliant minds.

73. NASA Goddard is still an institution that has a sufficiently large number of talented and self-motivated individuals who make it possible for good things to happen in spite of the management.

74. Flexible work schedule has been a welcome addition.

75. Most of my coworkers in the branch are about the same age as I do and we came in to GSFC about the same time.

76. I find others' apathy about winning future work to be infuriating and yet others' enthusiasm about winning work highly motivating.

77. Just my own work ethic and sense of responsibility

78. My motivation stems not from the organization, but from my own personal values. My motivation would be the same regardless of what organization I worked for.

79. Who is leading AETD and who is leading Code 580.

80. Challenging work, recognition of efforts, and the fact that we are cared about as people not just employees

81. Good technical work, concentration on getting the technical job done, not on the processes.

82. No

83. The work place culture has changed. I am getting conflicting messages regards performance review. Unsure what needed to perform well. Follow order or make decision to act upon. Regardless, I like to work in this organization and would like to do my best to meet the agency goals.

84. Too often, this organization devalues those that are actually doing the day-to-day work while over-valuing the stars.

85. The Freedom To Work At Pace; To Get the Job Done Right the First Time!

86. Managements lack of consideration and factoring in of the lost productivity (time and money) for everyone during the NOMAD transition.

87. Politics between and within the all branches.

88. Management support of growth -acknowledgment of outstanding performance -organizational support of leadership development -growth potential

89. A promotion would motivate me further

90. It's nearly impossible to get a promotion to GS-14, because, contrary to management's insistence that there is a dual track (managerial or purely technical), there certainly is not. The absurd promotion criteria are strongly slanted toward managerial type work, which I am not at all interested in. Further, my skills and abilities are not being used at all; instead, I'm assigned to work for which I have very little background or experience.

91. I have a tremendous amount of respect for my colleagues and want them to respect me as well. The work that I do is challenging and fun.

92. Personal pride and self-motivation Opportunities for diverse assignments

93. My work is primarily motivated by my own desire to do a good job and interest in the project, scientists, and other stakeholders and customers involved in my project.

94. Unlike my previous job working for JWST, my current assignment has management which seems to understand realistic schedules and engineering processes.

95. Level of appreciation Politics (negative motivation)

96. I am able to make and work independently.

97. like the work and the challenges; flexibility of hours

98. The craziness with ODIN and NOMAD make it difficult to get the computing tools I need to do my job. I spend too much time working around the system in order to get my job done. The system should HELP me get my job done, not but up roadblocks at every turn.

99. Personal drive to do a good job

100. The other engineers that a work with are also a motivating factor.

101. Self centered nature of AETD instead of working towards the greater good of GSFC and / or NASA. Appears to be motivated by short term solutions.

102. Recognition for extra effort

103. Work load

104. Well, I am kind of in a unique situation. At the time of this survey, I am seeking a job opportunity outside of this organization. After 8 years, I find that the organization and I are no longer a match.

105. Having more time for job training and not being thrown into a job.

106. Exciting work. Excellent supervisor and management chain. Great team.

107. Family Life style

108. Whether or not my career goal align with the organization's mission.

109. Being given adequate time and resources to the job right.

110. The factors that affect my motivation come from within and in no way reflect the values or policies of AETD. My factors are: 1. a desire to stay technologically competent,2. an intimate curiosity to advance the state of the art, 3. self motivated direction of which technology areas to pursue and develop.

111. At this time, the United States Federal Government is the best place for people with disabilities to work for. The policies that the government has instituted for people with disabilities is the best in the country and are routinely enforced, unlike private companies.

112. My coworkers level of motivation, dedication, skill, integrity... how reasonable upper management's decisions seem. overall funding. management piling more and more secretarial work on highly skilled workforce.

113. Stimulating intellectual environment goal oriented mission exceptionally talented colleagues

114. We cut a lot of corners for dubious reasons. AETD should be focused on developing and guiding the BEST engineering practices.

115. Over constraining procurement rules especially for 50K to 500K buys 2 Better institutional budget pots for facilities and lab equipment (not redoing perfectly fine concrete sidewalks) 3 Better consistency with projects awarded to GSFC 4 More in house development of instruments w.r.t earth science

116. I have a young child at home and would prefer to spend time with him rather than putting in extra hours at work.

117. Being sincerely appreciated by management and coworkers

118. There dose not appear to be any benefit to getting a Distinguished performance rating year after year.

119. New technology, kind of work

120. The meaningfulness of the work, as perceived by the larger community.

121. Promotion potential, flexible work hours, understanding by management of employee situations.

122. Job assignments and promotion potential

123. The money I make.

124. I am pregnant so my motivation for working is changing based on I have different priorities in my life right now.

125. I feel much of my past work experience has uniquely prepared me for the job functions I now perform. It is as though I was destined to become part of this organization

126. Interest in the nature of the work itself. Learning about new subjects. Coworkers.

127. The civil servants and contractors in my organization are a fantastic group to work with. I get to participate in almost all major projects that come through GSFC. That makes the work exciting.

128. Hands on hardware is key factor

129. Management infrastructure; old school management style, only looking upward to please those above without regard to the team doing the engineering work. No genuine support from upper mgmt.. finger pointing and blaming rather than support and collaboration to find best solution to problems Number of hours per week required to perform job are excessive.

130. I would be more motivated if we had some _real_ parts of Constellation to work on - spacecraft to design.

131. Support from direct line of Supervisor

132. The tendency by management of transferring non-engineering duties to engineers has been accelerating. This practice has greatly decreased our effectiveness as engineers.

133. Work I am doing, people I work with, and proper recognition of my level of work

134. PROJECTS! If the project is interesting, I'm interested. If its mundane, I am not motivated. I've worked on both kinds but more often mundane.

135. Opportunity for advancement affects my motivation in my current work situation.

136. Job satisfaction

137. Personal recognition (not reward). A sense of belonging and not a structured evaluation; it can be demeaning after 20 years of employment. High School principle style of management after 20 years. Respect for the time spend and the past successes. The phrase, “This is how it is you have to live with it” no input allowed on your part. Full Cost Account doesn't make any sense. Lack of a motivator; a, “You can do it person” The email contact with no expression culture. The Human Element Not knowing how I am connected.

138. Flexibility in work (i.e. often able to work outside your specific discipline but still within the broad range of work done in AETD)

139. Type of work. Perceived value. Encouragement from leaders.

140. I have recently worked on a project where I have witnessed some of the most inefficient management I have ever seen at GSFC or at NASA. I have worked at GSFC for nearly thirty years. I have wanted to work for NASA from the time I was 5 years old. I have worked here since I was 17 years old. When people ask my why I would want to leave, I have to admit it may just be a case of, “Been there, done that”;

141. I get annoyed by the constant reminders from multiple people to do the mandatory training like IT Security, Ethics, etc... It's as though management feels that those deadlines should override the real work that needs to be done on Flight projects.

142. From a positive motivation perspective: Overall culture and co-workers. i get to work with some great people, but the organization has lost some of it commitment to the workers welfare. Many benefits (tangible and intangible) have eroded over the last few years. I am motivate by being part of something larger than myself, whether helping inspire future generations (by supporting folks like Dr. Mather, HST..) or by working with folks (Jim Hansen, Mark Schoeberl, Jon Ranson, Franco...) who are actively working everyday saving the earth and preserving our future.

143. First line managers, where they are technically competent and quick to respond to any issues that I might have

144. Ability to technically challenging work truly understanding failures and anomalies.

145. The support of my management - the high quality of my peers

146. Ability to work part-time to balance work and home needs.

147. Getting older, wondering what I've accomplished over the years and whether or not I would have been better off elsewhere.

148. Home life

149. My co-workers and team spirit.

150. Personal work ethic

What, if any other, TECHNICAL/PROJECT SUPERVISOR behaviors affect your motivation in your current work situation?

1. I like way he is willing to let me tackle new tasks, even things that I don't have a lot of experience with.

2. It was discouraging after working on a project to be told that due to budget limitations I was to stop charging to that particular project.

3. Flexible behavior, tolerating and encouraging risk taking, guidance/advice

4. Project supervisors are principal investigators, who are incapable of managing projects effectively because there is no requirement for management training for principal investigators at GSFC.

5. I'm matrixes to an excellent manager in code 400 - he treats me like a equal member of the team -- some code 400 managers don't treat everyone the same. The pecking order is simple: code 400 employees are 1st for awards, key job opportunities assignments, conferences. Everyone else, contractors and Matrixed employees are next.

6. The majority of my daily motivation comes from the project I work for rather than my home AETD organization.

7. Unclear in telling me about my work objective; changes ideas frequently

8. Being part of a Project, it is what motivates me. Doing a job with a mission focus with a collective mission / project team is of the utmost importance to me. The ability to perform as a team and learn new aspects from others' experience with an end goal is the main thrust of my motivation. Working as a team in a Project environment is key for obtaining maximum performance.

9. My Technical Lead is very conscientious of employee development and placement. His encouragement and true appreciation for people makes me want to work for him.

10. My motivation is technical. The technical project lead's motivation is ambition.

11. I would have a difficult time working for someone I don't respect; luckily that has never been a problem here.

12. He is always there working and sharing in the work, which makes me want to contribute more as well.

13. I have a good leader and it makes coming to work to do job fun

14. I recently changed what I do for the organization and I have been very happy with how my technical lead has helped me to understand the new role I have taken.

15. I actually have two technical supervisors, and one chain of command manager. The scores for the second manager are quite different and the line manager is very disassociated from the day-to-day efforts. All-in-all I rate the management chain highly.

16. N/A

17. I answer to 2 technical leads (both outside of GSFC) and a project manager (at GSFC) in addition to my administrative supervisor. I answered the questions based on the leader (one of the non-GSFC leads) who motivates me the most to do my job. The person shows enthusiasm and a motivation to get things done (and done well), which in turn, motivates me to do the best job I can. The leader is very successfully at making me and other members of the team feel important to the team and demonstrates true appreciation for our contributions.

18. It is a factor. There are times that I feel we are just not in sync and it becomes difficult to continue working in this organization.

19. Providing adequate (engineering level) computer and software

20. My supervisors really stay out of my hair. I have a better idea of what is to be done and should be done than they do. Only on occasion do they come and ask me to do something, and it is very seldom that I am not on it before they come and ask.

21. Management making quick technical decisions without a thorough overview of engineers design decisions or results, cutting corners, and misuse of authority by project managers.

22. Practical way he approaches challenges, and insures that the best possible solution from a systems perspective

23. I am matrixed. Responses reflect average of project and direct line supervision

24. Technical knowledge

25. None.

26. Provide support for training.

27. His ability to give clear expectations, and accept best efforts.

28. Interests in my opinions and assessments

29. No promotions or recognition

30. My project manager is very concerned about the people on this job --my project manager is very sharp technically

31. My organizational supervisor (the one who does my performance assessment) is in another code from my technical manager. Organizational supervisor is hands-off. He has no clue what I am doing

32. My direct supervisor is great about helping me when I need it and letting perform the task that he has asked of me without staying over my shoulder.

33. Again, I'm not affected by my supervisor’s behaviors. I'm fortunate to currently work for a PM that respects me and my talents, however, I've had supervisors whose leadership/management skills were lacking, but my motivation was unaffected.

34. They don't communicate well, hoard information

35. Current technical lead is not knowledgeable of the systems but got that position because of friendly with manager.

36. Involvement in decision making process -team building

37. It would be nice to know clearly what my responsibilities are. The only responsibilities that I have are the ones that I've written.

38. My technical lead is very good at building a cohesive team and creating pleasant and efficient work environment.

39. Respecting my technical expertise when addressing technical problems or situations

40. These answers apply to my previous assignment on JWST not my current job working on SMAP

41. N/A

42. Is very forward thinking; at times has to “push back” on AETD

43. Once again, my answer to this question will be slightly different do to my situation! My supervisor is great! So great, in fact, that she not only fully supports my relocation to another Organization (within Goddard), but is helping me find the best fit for me! I am very motivated to support her, as she supports me.

44. Not getting the proper credit for work done well.

45. Competing priorities hurt my performance at times because managing my time to work on each becomes a challenge.

46. Politicking between line management and project management.

47. Attitude, willing to let me make of the work related decisions

48. None

49. He is very motivated and is a work horse. That inspires me to do a complete and thorough job so I am also a contributor to the overall task.

50. I work for 3 different PIs on 3 different projects so this section is hard to judge. A technically competent and motivated manager is critical though.

51. Extremely competent, very good administratively and technically, excellent judgment

52. Respect, challenges, encouragement, empowerment.

53. I have recently worked on a project where I have witnessed some of the most inefficient management I have ever seen at GSFC or at NASA

54. There's 1 person on the team that has really brought down the morale. He rarely comes in early, never stays late, and refuses to work weekends. Meanwhile everyone else is supporting these odd hour tasks & having to pick up the slack for him. The team would like to see our supervisor officially get rid of this guy but the supervisor gives him the benefit of the doubt.

55. Personal pride.

56. Technical competency is very important

57. The approachability of my management

58. I get the sense that I've been tagged a certain way, e.g. being a slow worker, and it makes me feel self-conscious when interacting with my lead -- sort of a negative halo effect. I get the feeling that my management communicated this to my lead from the start.

What, if any other, ADMINISTRATIVE SUPERVISOR behaviors affect your motivation in your current work situation?

1. I am motivated by what my next work assignment will be.

2. Not micromanaging. Support in approaches.

3. The re-organization could have been handled better by getting more employee feedback

4. Current line management is technologically illiterate and inept at basic management skills.

5. Branch management has been so incredibly fluid lately that I don't have much to say about them. Yes they are around and usually approve time cards and if I publish something or apply for training they have an admin quote me the procedure. They also are pretty good at notifying me of required training.

6. I stay in this branch and at this job because of loyalty to the project -- they need me to do this job. I will leave this branch (probably to another in AETD) as soon as the project is done. Being a good supervisor for embedded matrixed employees takes a unique set of management skills, and AETD has very few managers that are any good at it. (sorry).

7. Don’t see him much

8. My supervisor shows interest and is willing to listen and offer suggestions for my matrixed duties. The supervisor understands the commitment to the Project I am matrixed to and does not seek to subscribe me to other duties.

9. Understanding my work assignments as they come from other sources yet still helping me plan my career and helping me resolve issues

10. Professionalism is a serious matter. There is a lack of civil and polite behavior on the part of Branch Heads/Assoc. Branch Heads. There is little to no time allotted for basic polite treatment in common interactions. Yelling and screaming are accepted as the Assoc. Branch Head/Branch Head's, “management style.” Assoc. Branch Heads are competitive with subordinates and are not above using less than savory/ethical tactics to achieve their goals at the expense of, rather than in support of, their subordinates.

11. As good as my technical lead is, by branch head outshines him by quite a ways. He is quite simply one of the best supervisors out there.

12. I really don't like it when I mention an issue or problem to my supervisor and they don't do anything to bring closure to that issue. They may just say, well, I understand your problem but I'm not going to do anything about it. That's not good enough. That may hinder progress.

13. As far as I can tell my Branch Head is doing a good job. However, his behavior does not generally significantly affect my motivation. This is true because as an experienced/independent mission system engineer who is matrixed to a flight project, I spend nearly all of my time dealing with flight project issues (technical, programmatic, workforce, costs, etc.).

14. They don't have a clue. Send them off to do the job. If the customer (code 400) complains get a new person from 500 to do the job. Just give the customer what he wants so we get paid!

15. In taking on a new job I changed branches and have not had much interaction with my new branch supervisor.

16. Communication here is sporadic and could use more structure. I see my administrative supervisor on the order of once a month.

17. My supervisor was hired in as a former contractor, worries more about them and acts more like them and sides with them on all issues, they have far and away too much power and presence here--including offices on site intermingled with civil servants who oversee their work. Because of this ‘favoritism behavior”, contractors are extremely rude and uncooperative to civil servants.

18. Caring, appreciative, listening

19. My supervisor allows me to do what I need to do for the job without trying to micromanage me, but is available and willing to help when requested.

20. It is good to know that my supervisor understands and is willing to listen to my concerns and issues.

21. I perceive a difficulty getting access to training opportunities that appear to be politically driven.

22. I have had 4 supervisors in the last 5 months. The earliest of those, i.e. the one I have had for over 12 years, has been very supportive, and this report addresses that supervisor. The level of support provided is a great motivator.

23. Good communication between supervisor and employees.

24. I am matrixed. My AETD (584) supervisor has helped me through a very difficult problem with a coworker.

25. My supervisor (and predecessors) not necessarily supported realistically by upper management (i.e. information flow, consistency between branches, divisions in applications of standards and work assignments)

26. Lack of knowledge of what is really going among the teams in the Branch

27. None.

28. I don't believe that my administrative supervisor really understands the work that I am doing.

29. Willingness to discuss work assignment

30. Again, no promotion or recognition

31. I have a new branch head, so I don't have much of an opinion right now. In the past, it was awards and good performance appraisals that had the biggest impact on my motivation. The other big motivator is genuine concern on the part of the branch head in the organization's success.

32. He has a tendency to try to fix my perceived weaknesses and not give me credit for my strengths.

33. Right now, I'm working in a new branch. Branch management seems to be doing the right things, but I don't have a long experience with them yet.

34. Too cynical

35. Again, I am assigned to work I am totally unqualified for. I have expressed this sentiment. I have not been heard.

36. My supervisor cares about doing important work.

37. Same statements as above.

38. My supervisor is very good but I am matrix to a Code 400 project and interface with the Code441 Project Management for most technical issues.

39. My administrative supervisor has only been in the position for one week so answers are really unknown at this time; however, having worked with this person in another capacity, I expect given time my responses would all be “very satisfied.”

40. My BRANCH HEAD some time does not support us with his management

41. Feedback, would like more

42. The ability to get promoted has affected motivation.

43. Branch Head has only been in his position for two of the six months I have been in the organization. This doesn't impact my motivation, but impacts my ability to rate most questions.

44. Having my concerns and/or ideas listened to thoughtfully is a great motivator.

45. I like the fact that my branch head has an open door policy, he understands the challenging nature of our work, and that he's willing to go to bat for me.

46. Administrative Supervisor is often constrained or over burdened with administration from the level above. Not allowed to manage creatively.

47. Best jobs go to friends

48. My supervisor is very supportive and reassuring when it comes to doing my job.

49. I just happen to be lucky to have an exceptional supervisor. I have been at GSFC for more than 20 years and ALL of my previous supervisors were assholes.

50. Politicking between line management and project management.

51. Supervisor should be intercepting more of the tedium from upper management so we can better get our jobs done.

52. None

53. I appreciate their integrity and the consistent way that they have supported their employees in front of the upper management. Often they have been helpful as to how to avoid bombshells with upper management and presented the best way to proceed.

54. The degree to which something is stated as “really important.”

55. He is useless, he gives no input to his employees, and tries (unsuccessfully) to keep control of everything to himself, and he takes no input from even his most senior employees.

56. The most significant factor my administrative supervisor's behavior has on my motivation is the fact that in my 20 years in this branch I have NEVER been given a pat on the back, NEVER been put in for an award by my branch, even though my work performance is above and beyond the performance of other engineers in this branch.

57. Being given a clear vision of what our organization will be doing with in the next 5 years.

58. Administrative supervisor has little to do with my project work. Administrative supervisor is very people-oriented and that is what is needed in all administrative management positions. Administrative management has little bearing on my motivation- my motivation comes largely from me.

59. We are not in High School; I don't need a High School Principle; I need a facilitator after 20 years. I don't need to be told; you did this wrong. I need to be asked if you need help or more time. Back me up when the chips are down. Don't tell me it’s my fault.

60. I don't know if my supervisor is backing me up with management. Unfortunately, the guy who won't work late or work weekends seems to be the person who has the highest priority of getting promoted despite his shortcomings. My technical lead has not relayed these shortcomings to management because he's too nice to say anything negative about the guy.

61. Personal pride and satisfaction.

62. Technical competency and quickness in responding to issues

63. The approachability of my Branch Head

64. I have a new supervisor that I'm sure I'll be much happier with. Since I have just begun to work with him, I have responded in the survey regarding my former supervisor.

What, if any other, intrinsic factors affect your motivation in your current work situation?

1. I am motivated by the people I get to work with.

2. Applying logic and organizational skills

.3. Lack of funding from HQ

4. I find the work interesting and challenging, and the work relationships satisfactory.

5. Everyone wants to feel that they belong and to feel that they've contributed. Sometimes when the politics are high or the management layer is feeling the pressure of mission launch its easy to forget all the essential people working on a mission.

6. Fear of failure. Fear of “not knowing what I don't know.”

7. This project is extremely challenging on many fronts, the team we have in place is top notch, and I like the GSFC campus.

8. A sense of responsibility.

9. Since I am new to my current job I am still a little unsure that I really know how to correctly do this job and what is expected of me.

10. My lead has confidence in me to do the job.

11. I went out on my own initiative to get this prestigious agency level job and my motivation is that I am determined to uphold my promise to God to work to the best of my abilities and to the Program who put its faith in me to ensure its success.

12. The skill-set needed for my current position is much different than it was before. Specific training for most of it has not been provided. OJT is being provided in one area at an adequate level with a jump-in-and-swim in the others.

13. None

14. Flexible work hours

15. Current paradigm is causing frustration and morale decrease

16. The opportunity to learn new and different things.

17. Upper management making decisions.

18. Access to announced training by securing the needed recommendation when few slots are offered. Again my perception is that these slots are probably filled by always the same people based on who they know.

19. I have done this job for 18 years; the greatest challenges are the people I have to work with. Occasionally a challenging technical problem comes along, but I have never seen something I could not solve. When personality issues come along it can be a great de-motivator.

20. the people i have to interface with, the dynamics of a team, the willingness to work together.

21. My work is very specific, and that makes it relatively easy to master, compared to other disciplines.

22. Information flow and communication between individuals, teams, branches, contractors, other orgs. Practical application of doing the right thing vs. time and money wasting rigid standards that are simply not effective (quality vs. process).

23. Team members' schedule

24. None.

25. Feedback from co-workers.

26. Availability of training for technology advance and opportunity to decide on how learned skills are applicable or whether technically advantageous or not to goals of group

27. We don't get feedback until it is time for performance appraisals. And even then, the supervisor does not know what we have worked on so, we are asked to summarize it in a list and the supervisor reads through it like some "surprise epic novel," - really!? "I had no idea you were sooo active and doing soo many things," says the supervisor. It's the same story every year... really pathetic.

28. I like to be challenged, so I don't ever like to be in a position where I feel I have completely mastered the skills.

29. Does my job challenge me?

30. Current assignment is not my area of expertise; thrown in w/o opportunity to come up to speed. Look like a doofus.

31. There is interesting stuff to be done.

32. Too many meetings

33. Training. I have been given none. I've noted that the contractors that do similar work on the contractor side are put through extensive training. All my training is On-Job-Training.

34. The organization has a hard time keeping those talented individuals who can help in developing new ideas.

35. The work I am doing is important.

36. My Experience on the Job and Training.

37. NOMAD and how its making me less productive and the fact that management does not understand this or doesn't care

38. Lack of recognition from upper manage management

39. Acknowledgement of performance from technical manager/lead

40. Historical knowledge about the project and or work activities sometimes affects motivation i.e. trying to overcome a learning curve.

41. The work I'm doing has almost no relation to my education and training.

42. There are constant opportunities for growth and learning.

43. Personal pride the desire to do an outstanding job

44. The satisfaction of helping others to do their jobs; the satisfaction of being able to support the projects I am working on.

45. Having reasonable programmatic expectations from the Project management is key to success. Too often project managers and instrument managers sign up to "; Green light," schedules and unreasonable costs.

46. Challenging work, monetary rewards

47. N/A

48. Overload of work from multiple assignments

49. Obtaining computing resources (Macbooks, software and iphone) is severely constrained. Without extra effort expended to obtaining the proper computing resources for the way I work I could not do my job well.

50. My independence and mastery of my job fundamentals as well as the chance to occasionally try new ideas or invent/test new ways of doing things makes my job rather ideal and approaching a dream job.

51. GSFC's strategic planning and vision (lack there of).... several other NASA centers out pacing GSFC...

52. I did need more training for what I am doing, but the training was not available.

53. I am motivated to help my team do the best job we can.

54. Not being able to have suggestions or decisions I make treated with respect by systems engineers.

55. 1 Difficulty extracting contractual agreements w/ institutions supplying instruments and working with several other Gov organizations that are managing their development.

56. Know my work well

57. Pride, personal reputation, and the engineering group's reputation.

58. Pay day

59. Previous flight instrument experience.

60. The work I do draw heavily on my experiences, judgment, team leadership, and innovation. Every study has problems to be solved, and I love doing that.

61. Deadlines in the form of administrative work, mandatory training and meetings are often a distraction that interferes negatively with technical work.

62. To satisfy my customers, usually external to AETD

63. The type of work I do, and the people who work for me, and with me.

64. Knowing that I have management support in obtaining resources that will allow me to do my work effectively (i.e.: training, equipment, etc...)

65. My job is very demanding and requires constant technical judgment regarding the work performed by many external organizations (university teams and teams from other NASA centers). I must motivate and encourage technical excellence and timely work from those organizations in order for all of their software, systems, and interfaces to be ready for operations at spacecraft launch.

66. People I work with, nature of the tasks, schedule to complete the effort, interesting/challenging

67. It would be nice if the management were more aware of which employees are working the extra hours & /or going the extra mile. Unfortunately, their efforts to promote the person on the team doing the least makes it clear that they are unaware of the extra efforts the rest of us are making.

What, if any other, extrinsic factors affect your motivation in your current work situation?

1. I am motivated by the work I get to perform.

2. Office politics.

3. Being required to take the same training too often.

4. Traveling is too difficult. Computer support is poor. Charge code pressures seem inappropriate.

5. Managers need to be more proactive and less reactive -- to be more proactive managers need to be more engaged. To be more engaged managers need to meet with their staff members and listen to them.

6. Much of the paperwork I do adds value. The part I hate is the written status reports that are different for each organization I report to. The work is the same; most of the managers want to avoid surprises at their upper level meetings, so a single report should suffice. But it never does. Each organization wants its own report -- and it kills about 3 hours of my time each week. Yuk!

7. There is a neglect of how adhering to some ethical guidelines may result in a perception by the public of a civil servant as being rude (e.g. accepting a simple thank you gift from a visitor) or as withholding (e.g. the inability to make a public statement about the implications of one's research). The whole fact that we are led to believe that we have to be in a state of hyper-awareness when it comes to interacting with the general public and non-civil servants takes up necessary brain space and creates a distance between ourselves, contractors, and the general public. Re-defining these rules to make our Agency more fluid in the face of simple interactions would improve our public perception and free the minds of many a civil servant of unnecessary thoughts

8. Too many passwords and they require changing way too often; too many different accounts; the eOPF is total mess; the directorate/division computer technical support is horrible

9. The amount of required training that is always popping up. It seems that we could just declare at the beginning of the year “here's the training for the year and you must complete it all by this date.” Instead of getting messages throughout the year announcing each requirement separately.

10. There is too much emphasis on extensive training on issues not related to the work that I do. The Training Office ladies were really miserably ugly and awful to me when I wanted to take training in my area of interest and did everything in their power to make sure that my application was not even remotely considered.

11. Flexible work schedule

12. We are too institutional to be competitive

13. Having to repeat similar information in different formats for multiple leads/supervisors has a negative effect on my motivation. I feel like it takes time away from the “more” important technical work I am responsible for.

14. None.

15. I am proud of our former accomplishments at NASA. I am greatly saddened by the administrative burden and wasted time presently placed on us to do meaningless systems management. I strive to maintain a high level of engineering, technical superiority, and productivity in hope that we will one day return to the ways that made us successful.

16. Obviously there are branches/divisions who have promoted some people to ridiculously high levels. This skews the norm for others.

17. None.

18. Every new policy from the Center, AETD, IT security, or Security seems to make things more difficult to accomplish.

19. The opportunity to work on good teams is important 'good' means the team is interested in functioning as a group in order to achieve its goals

20. After five-seven years of working here and receiving your raises etc there really are no real incentives-monetarily speaking...

21. Amount of paperwork...should be more online/paperless

22. There is too much mandatory training.

23. Expecting engineers to do procurements & other admin work is a waste of taxpayers money. It is much more costly to have an engineer who rarely does admin procedures waste expensive time muddling through when a competent admin can do it well & cheaper.

24. All technical work is done by contractors with nothing left for civil servants to do but management.

25. Regarding 33: I personally receive more than enough recognition from other institutions outside of NASA.

26. More and more “busy work” is being pushed down to the technical level through the use of web-apps. Examples: P-card, iProp, etc.... It makes no sense to pay a GS-14/15 to do administrative assistant work.

27. This comment isn't related to the extrinsic factors; it's related to the distribution of rewards. What I've noticed at Goddard is the FUMU policy - if you screw up you get moved (promoted) up. I've worked on projects where people have make decision that have resulted in major problems; they fix the problem, and get a promotion or significant reward for fixing a problem they created. Also, I've seen people bust their but working hard, seemingly effortlessly, and not get rewarded because they consistently provide exceptional work. Both of these scenarios are de-motivators. People should be rewarded for providing exceptional work even if they do it consistently year after year, but this whole culture of wanting to reward everyone regardless of their contribution precludes this.

28. The pay isn't bad... it’s just communist. There seems to be very little link between performance and pay. I would prefer that these had a much more direct link. Giving out carrots for good work is only motivating if the mediocre worker doesn't get the same reward just because he/she is there.

29. Slothfulness of Others.....

30. NOMAD transition has made me and other less productive and nobody acknowledges or realizes it.

31. None

32. Engineers are expected to juggle many administrative tasks: procurements, manage contracts and tasks, etc.

33. Unrealistic project schedules

34. Unreasonable and unrealistic requirements in rules and procedures sent down from upper management without a corresponding increase in resources to be compliant with those rules and procedures; the sheer volume of rules and procedures the NASA employee has to know makes the job very boring and takes time away from the employee to do really important work.

35. N/A

36. Insanity of ODIN and NOMAD and the negative impact it has on trying to get the proper computing resources that I need to help me accomplish my work in the best way for me. ODIN and NOMAD try to force everyone to work one way, and unfortunately for me that way is not compatible with the way I work and think. NASA needs to put helping the employees do their job ahead of making the job easier for the information technology people.

37. Little too much focus on process only and not on product.

38. So many meetings, but I do understand that’s part of the job.

39. Politics overrule engineering on a regular basis.

40. Constant training and retraining. I have been here 15 years. It never was this complicated. Property training. IT training. Ethics training. Over and over and over.... and over... and over... bleah!!!

41. I am dissatisfied with unequal benefits because I am in a same-sex marriage.

42. Money

43. Need more clerical support.

44. Ask me how I am doing; don't tell me how I am doing.

45. A agree with most policies. It is people I disagree with.

46. Administrative training classes

Feedback & Comments

1. This survey was easy to complete and not too time consuming.

2. Some questions are tricky. Need to use positive or negative queries consistently.

3. Length is ok, fairly clear, appropriate - no major issues.

4. The instrument was generally clear. Some of the Tech/Admin Lead assessments were subjective. Not certain that I had any strong complaints given the categories to select from.

5. Web access easy; length and clarity okay; operations engineering and management not listed in the disciplines.

6. Good overall. Some questions, like benefits, were tough to answer because there are different answers for different kinds of benefits. Could have been more N/A and/or neutral choices. I answered one question narrowly, thinking only of my division re-org - but it may be reflective of AETD mindsets about re-orgs. Good luck!

7. Overall this was easy to complete and straight forward.

8. Excellent survey. Better than the supervisory feedback tool. Hopefully this research can be used to expose the current dysfunctional management that exists within AETD. Good luck.

9. When I got to the section on Project managers, I wasn't certain you wanted me to talk about the organization I'm matrixed to (outside AETD) rather than my home branch (in AETD). I'd probably put all the sections about AETD together, and then add the questions for matrixed employees at the end.

10. I thought the survey was appropriate length and appropriate for the audience. Good luck with your dissertation!

11. Very good job; clear and efficient

12. None.

13. This survey was total bull****. It was too long. After about the 5th or 6th screen, I just started answering the questions haphazardly.

14. The difference between matrixed organizations (such as working for a Project) and home organizations (such as AETD) can lead to conflicting comments.

15. I found the survey to be easy to manage and not too long. Some of the sections could have gotten tricky because questions alternated between positive and negative statements. When entering agree vs. disagree there was potential for marking a box that was not intended.

16. This questionnaire was not as excruciating as others. This was very concise and to the point. It took me less than 15 minutes (which is a good thing).

17. I don't really consider myself an “AETD” engineer as much as a “NASA” engineer, and as such, it is difficult to rate AETD as an organization. Some of my personal issues with my current job are quite specific to my project, and have nothing to do with AETD, so it wasn't clear how to answer the questions.

18. I hope that you can use the results of this survey to _quickly_ feedback changes into the system. We need significant and immediate assistance in turning the tide towards positive and constructive action! Thank you for taking the time and making the effort to study us!

19. Length of the survey was perfect, instructions were simple and easy to follow, would recommend adding in outside factors (family, home, hobbies, etc.) that affect our motivation at work and how they play a role in what we do at work, and what we can do as an organization to help people balance their lives and careers.

20. This isn't the SATs so to assure you get the answers the participants intend to send I find it is helpful not to mix up positive and negative statements in a section. People tend to skim statements when they are just squeezing this into a full schedule.

21. Very good survey. Unless some other surveys, questions and responses were very well phrased.

22. Very, very good questions!

23. I hope my/ the information you receive help the Goddard community.

24. Seemed pretty easy to complete

.25. A little long...and why do you need the demographic info. It's quite specific...I thought the next question would be what my building and room number was.

26. Questions 27 and 29 were not clear.

27. For the most part it's fine. The matrixing of employees makes research into oversight difficult to survey. Good luck in making effective use of the aggregate information.

28. Some of the phrases in the survey were written as a negative and some positive, which made it a little confusing when selecting level of agreement. It would have been more clear if the phrases were all positive or all negative. I had to read some of them very carefully.

29. Simple & straight forward.

30. Well done, good questions and repeat questions make sure people are sure of their opinions.

31. Good survey

32. It's a good survey. It will be interesting to see what data is accumulated from it and how it is used. The instructions in some cases could be clearer, especially for those in highly matrixed organizations. Some of the items in question 33 could have been worded better (e.g., “I do not feel that the work I do is appreciated” would have been clearer to answer agree/disagree if it had been worded “I feel that the work I do is appreciated” or “I feel that the work I do is unappreciated”) The web access/interface was easy (I liked the fact you could go back to previous pages).

33. I felt the length of the questions was short. The questionnaire took the time estimated which in my experience is typically not the case. I felt the questions were clear and to the point.

34. Thorough set of questions. You needed a panel of questions about continuing education for engineers because this is a critical area for technical and engineering mgmt.

35. I think you touched on many aspects of the work experience in trying to meet your stated goal. The survey took a bit more than the 15 minutes.

36. The survey is clear and easy to follow.

37. Good Luck!

38. I am very interested in the results. Good luck!

39. Questions were very general. Sources of job frustration and problems for most engineers are usually more rooted in inability to build the best widget possible for a reasonable amount of money in a reasonable time given the fact that these are all unique never before built widgets. Benefits wise- would think that you would want to know which areas are good/not good. Overall people may perceive a package to be pretty much ok but it will be the areas that it is not ok that could drive them to leave the organization.

40. Wasn't sure if “supervisor” in later sections (e.g., intrinsic values) meant project lead or administrative manager. (I answered w/ project lead in mind.) Good luck!

41. Some questions are confusing. I would help if all the questions are written in a positive statement and then all the answers will flow better in the “agree or disagree” category.

42. Working buttons on a web page is nice. i have no ideas for what you are attempting to accomplish.

43. Extremely well organized and thought out. I think that the results of this survey will be very valuable. I would very much appreciate any output resultant from this study.

44. It is difficult to perform these surveys all the time at work. There are many surveys throughout the year and we never seem to have time to do them.

45. Ok

46. I liked the wording of the questions. They appear to have more significance than questions in other surveys I have taken

47. would like to see results of the survey if possible • length is appropriate, I don't like surveys • some questions may not apply very well to me in my current situation, so answers to these are put in the middle of range

48. There should be a comment box on every page of the survey not just every few questions

49. Thanks Howard. I hope they listen. I'm ready to quit.

50. It would have been nice to be able to save and come back later.

51. At first, I did not know what organization was referring to, NASA or AETD.

52. Not a bad survey. The feedback questions were a bit confusing--seemed to be asking the same thing twice.

53. A lot of these questions were about things that I rarely think about, and so didn't have strong opinions on.

54. Goddard is fixated on the process in getting a job done and seemingly not the engineer skill to do so. This mentality is my biggest disappointment in working at Goddard. I am sure I am not alone with this opinion.

55. I think my lack of job satisfaction based on being assigned work that I am totally unqualified for biases my answers. I was given an ultimatum: accept this work or retire. Even though the people and work are reasonable, I would call myself a “disgruntled” employee. I would rather have a job that I know how to do.

56. Survey was OK. There should have been a N/A response option. Also, why 7 response options? Seems odd!

57. Some of my answers may seem inconsistent with others - perhaps because I lead a small group (2 to 4) of engineers to develop new spectrometers and detectors. Many of these engineers are treated well beneath their intellectual merit and leave the branch - but still try to continue their work in my small group.

58. The survey wasn't too long, and the instructions were clear. Good luck with your research.

59. The questions are clearly and precise to provide quicker answers

60. The combination of positive and negative questions was a bit confusing (i.e. one line is “I am satisfied with how,” and the next line is “I am dissatisfied with how... .”)

61. Some of the questions were difficult to answer because I cannot speak on the organization as a whole. Nor could I compare AETD against other directorates at Goddard

.62. Good. Note sure what you are going to do with it. Some of the answer categories did not give me the option to answer as accurate as I wanted so I had to pick another answer.

63. The survey was very easy to complete. One minor suggestion is to word questions so that back-to-back questions do not have an “agree,” followed by “disagree” type of question.

64. Good.

65. This Was Okay! Clear and Concise!

66. There is lack of leadership opportunities in our technical work that would increase our chances for a promotion.

67. Survey monkey is good as long as you keep it simple.

68. None

69. Web access is great -Survey is just the right length to not become overwhelmed, maybe it could be a little shorter -I thought the questions were appropriate for AETD engineers -I think there should be a column for N/A

70. Had slight trouble with web access, but finally got it. The questions were clear, but some of them were not really applicable to me.

71. Okay, okay, okay.

72. Survey was easy to complete; questions are relevant and thought-provoking.

73. There were questions asked in the negative which made the survey a little confusing.

74. An easy survey to perform. Thank you.

75. A number of questions are N/A or unknown. Also difficult to answer if you are matrixed, do you answer wrt technical manager or supervisor. Answers may be very different

76. This survey was easy to complete

77. Nice survey. Consider making the questions consistent, i.e. all should be strongly agree for “good,” on one page rather than going back and forth.

78. Was a little confused about the distinction between supervisor and project lead the first time I went through the survey. After getting through it ,I understood which section applied to which manager.

79. Survey length was fine.

80. The survey was cool. I can’t respond too much in detail because I'm not feeling too well today (about to take some SL). Overall, the survey was not bad at all, just a little time-consuming when you're busy. :O)

81. The length and clarity of the survey were moderate. I hope my contribution to this survey will help you in the capacity you sought.

82. Questions were clear. Good luck.

83. Good luck with this. It would be nice if this could affect the way things work at GSFC and NASA, but unfortunately I doubt anything will change

84. A very interesting and thought provoking survey. On a few occasions there was no “neutral,” or “I don't know,” answer available when it was the only answer I could truthfully give. However, that actually only happened twice.

85. Nice project; would like to know / hear the results.

86. Format and types of questions were familiar. Questions seemed directly applicable to your objective and appropriate for AETD engineers.

87. Very good survey, I thought it is reflective of how this job can effect my career and how the people I work for have a huge influence.

88. Good luck with your research, I would be interested in hearing about the results. The survey was easy to complete and didn't take very much time at all.

89. I really think there is a serious problem on promotions at the center. The accretion process is way to subjective and the criteria is not applied the same across the board. In general, people are still promoting you they like and want.

90. It was confusing in the beginning whether the questions were for the AETD organization or my Project organization. I am matrixed and have very little contact with AETD. Many of the questions simply do not apply because I do not interact with my AETD supervisor on a regular basis.

91. Some of the wording was awkwardly written. I shouldn't have to read the question more than twice to figure out if it's a negative or positive in nature.

92. Good mix of positive and negative responses about the right length

93. Easy to fill out. A bit repetitive. Good spacing of free-form comment blocks (i.e. good to include them frequently).

94. Howard; GSFC has a wide range of activities that are trying to be covered by your survey. There are many nuances that can not be captured, nor do we really have control over since we are a Federal Government institution. Perhaps you need to do a small random sample interview process that is a little more probing.

95. It was clear and concise

96. The instructions were very clear and the length was just right.

97. Some of the questions did not have a neutral response. The respondent had to choose slightly agree or slightly disagree. For some, I really would have preferred to give a neutral response.

98. Generally the survey questions were alright; however, I would avoid questions that tend toward a negative, i.e., would not as opposed to would you or do you. It would be interesting to see the same question rephrased in the positive or negative to see if there is a difference.

99. None

100. The survey seemed appropriate and the forum was easy to use.

101. This form was easy to understand, and posed little ambiguity in my mind about how to answer the questions. Good form.

102. Some of the questions in the survey were not well formed & it would be easy to contradict myself due to wording of the questioning. Good luck on your PhD. Maybe you will finish since I never did.

103. When questions say “organization” it's not easy to distinguish between the different levels in AETD - my section/group, branch, or division - each has a different influence on my motivation.

104. Great job; clear and appropriate questions; reasonable length to capture adequate data base; good luck. Looking forward to the results

105. Excellent survey.

106. Easy and simple survey mechanism.

107. I will let you know when I hear the results of your survey. The survey tool itself was very helpful and easy to use.

108. The organization that you are talking about needs to be identified more clearly. Perhaps questions on 2 organizations, NASA/GSFC and your immediate organization. Also, I am matrixed so I have 2 different project managers. It would have been nice to rate on both, as it was I chose the more rewarding task. The other task would have gotten MUCH lower ratings.

109. People do a lot of different things in AETD so it may be difficult to generalize people in the organization.

110. Survey was easy to understand and complete. Good luck!

111. Blessings on your endeavor.

112. Great survey!!!!!!!

113. Interesting survey, I hope it helps you/the center.

114. about the right length

115. There were certain questions that seemed intentionally awkward in their wording. I found that very cumbersome. I'm trying to get through this quickly so I can move on to real work. Unfortunately, I'm reading & rereading questions to decide what the intent is to be sure I'm not answering in such a way as to contradict the previous question.

116. The survey was very interesting. I look forward to seeing the results of your effort.

117. I'm not concerned about promotions as a wish to remain technically “hands on”

118. Some employees have more than one technical/project manager. It was a little difficult to provide an overall rating for those specific questions.

119. Hard to critique when working more than one project at a time so have more than one project supervisor and usually have a tier of project supervisors to report to and deal with.

120. I think the survey covers all aspects of the engineering job position at NASA very well.

121. You shouldn't use the word “supervisor” for responses in reporting to technical/project lead and administrative/branch lead. It was a bit confusing in sections 7 (asking for responses to project) and then following questions in section 8 asking for response to supervisor.

Appendix F

Descriptive Statistics

Frequencies

Statistics

Mot_Scale Motivation Scale of 1 to 7

N	Valid	238
	Missing	0
Mean		5.28
Median		5.50
Mode		6
Std. Deviation		1.201
Skewness		-.755
Std. Error of Skewness		.158
Kurtosis		.238
Std. Error of Kurtosis		.314
Minimum		2
Maximum		7

Frequencies

Statistics

		OCQ_Mot1 Willing to put in great deal of effort beyond normal	OCQ_Mot2 Talk up organization to friends very positively	OCQ_Mot4 Would accept almost any job to stay with organization	OCQ_Mot5 My values and organizations' s values are similar	OCQ_Mot6 Proud to tell others I am part of this organization	OCQ_Mot8 The organization inspires my very best job performance	OCQ_Mot10 I am extremely glad I chose this organization over others	OCQ_Mot12 Often its difficult to agree with organization's policies on important matters	OCQ_Mot13 Really care about fate of organization	OCQ_Mot14 This is the best possible organization to work for.	OCQ_Mot3 Feel very little loyalty to the organization	OCQ_Mot7 Could work for different organization as long as work was similar	OCQ_Mot9 It would take very little change in my present circumstance to leave	OCQ_Mot11 Not too much to be gained by sticking with this organization	OCQ_M Decidin work fo organiz was n mista
N	Valid	238	238	238	238	238	238	238	238	238	238	238	238	238	238	
	Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mean		5.99	5.26	3.24	4.68	5.72	4.55	5.45	3.65	5.95	4.75	2.95	4.68	3.03	3.36	
Median		6.00	6.00	3.00	5.00	6.00	5.00	6.00	4.00	6.00	5.00	2.00	5.00	2.00	3.00	
Mode		7	6	2	6	7	5	7	4	7	6	1	5	2	2	
Std. Deviation		1.162	1.472	1.841	1.610	1.293	1.600	1.320	1.714	1.126	1.560	1.975	1.625	1.744	1.712	1
Skewness		-1.660	-.730	.374	-.405	-.951	-.527	-.437	.321	-.946	-.482	.763	-.423	.590	.332	-1
Std. Error of Skewness		.158	.158	.158	.158	.158	.158	.158	.158	.158	.158	.158	.158	.158	.158	
Kurtosis		3.683	.057	-1.166	-.655	.669	-.564	-.663	-.679	.382	-.463	-.738	-.611	-.823	-.946	1
Std. Error of Kurtosis		.314	.314	.314	.314	.314	.314	.314	.314	.314	.314	.314	.314	.314	.314	
Minimum		1	1	1	1	1	1	1	1	2	1	1	1	1	1	
Maximum		7	7	7	7	7	7	7	7	7	7	7	7	7	7	

Appendix F (cont.)

Frequencies

Statistics

		SWMS_Projsupr1 he way m supervisor listens	SWMS_Projsupr2 he way m supervisor sets clear goals	SWMS_Projsupr3 he way m supervisor treats me when I mak a mistake	SWMS_Projsupr4 he way m supervisor nsistent he behavior toward bordinate	SWMS_Projsupr5 he way m supervisor elps me g e job don	SWMS_Projsupr6 he way m supervisor gives me edit for m ideas	SWMS_Projsupr7 he way m supervisor gives me clear nstruction	SWMS_Projsupr8 he way m supervisor orms abo rk chang ead of tin	SWMS_Projsupr9 he way m supervisor low throu to get problems solved	SWMS_orjsupr10 he way m supervisor understand e problem ay face i the job	SWMS_rojsupr11 he way m supervisor shows oncern fo my caree progress	SWMS_ My upervisor acking me et a pat o ood work	SWMS_ rojsupr13 e frequen with which e technic ompetenc of my supervisor	SWMS_ rojsupr14 me I get t ork on tas fore bein moved to other tas	SWMS_ rojsupr15 e amount The time sp ve to do t job right	S VMS_ rojsupr16 he job nsibilit e clearl fined.	VMS_ supr17 way m
N	Valid	191	191	191	191	191	191	191	191	191	191	191	190	190	190	190	190	190
	Missing	47	47	47	47	47	47	47	47	47	47	47	48	48	48	48	48	48
Mean		4.16	3.82	4.12	3.99	4.01	4.09	3.81	3.73	3.92	3.88	3.66	3.95	3.79	4.23	3.85	3.73	3.78
Median		4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Mode		5	4	4	4	4	4	4	4	4	4	4	4	4	5	4	4	4
Std. Deviation		.951	1.010	.815	.992	.981	.871	.984	.998	.962	1.001	1.153	.956	.975	.906	.927	1.059	.998
Skewness		-1.294	-.966	-.756	-.970	-1.057	-.859	-.876	-.757	-1.025	-1.062	-.711	-.714	-.674	-1.412	-.656	-.677	-.879
Std. Error of Skewness		.176	.176	.176	.176	.176	.176	.176	.176	.176	.176	.176	.176	.176	.176	.176	.176	.176
Kurtosis		1.393	.672	.484	.537	.928	.442	.735	.264	.965	.963	-.150	-.031	.252	2.445	.232	-.171	.606
Std. Error of Kurtosis		.350	.350	.350	.350	.350	.350	.350	.350	.350	.350	.350	.351	.351	.351	.351	.351	.351
Minimum		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maximum		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Statistics

		SWMS_minsupe wasy upervis eats clea listens	SWMS_minsupe way r upervis goals	SWMS_minsupe way r upervis nsistente behavio toward mistak	SWMS_minsupe way r pervisor ehavior ordinate	SWMS_minsup e way r upervis ps me g e job do	SWMS_minsupe way ne way ne way ne way r upervisc upervisc upervisc ow throu to get problems solved	SWMS_minsupe way ne way ne way r upervisc upervisc upervisc ow throu to get problems solved	SWMS_minsupe way ne way ne way r upervisc upervisc upervisc ow throu to get problems solved	SWMS_minsupe way ne way ne way r upervisc upervisc upervisc ow throu to get problems solved	SWMS_minsupr ne way r upervisc upervisc upervisc derstan problem ay face the job	SWMS_minsupr ne way r upervisc upervisc upervisc derstan problem ay face the job	SWMS_minsupr ne way r upervisc upervisc upervisc derstan problem ay face the job	SWMS_ My pervisor ith which e technic ompeten of my supervisc other ta	SWMS_minsupr e frequen ith which e technic mpeten of my supervisc other ta	SWMS_minsupr e amoun me I get rk on ta fore bei moved to other ta	SWMS_minsupr he time p ve to do ob right	S VMS_ m nsupr e way r job nsibil e clear fined.
N	Valid	207	207	207	207	207	207	207	207	207	207	207	206	206	206	206	206	206
	Missing	31	31	31	31	31	31	31	31	31	31	31	32	32	32	32	32	32
Mean		3.96	3.67	3.85	3.68	3.58	3.84	3.58	3.67	3.70	3.61	3.65	3.81	3.53	3.89	3.74	3.62	3.60
Median		4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Mode		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Std. Deviation		1.028	.989	.958	1.059	1.076	.944	.996	.995	1.065	1.134	1.217	1.036	1.129	.977	.893	.970	.054
Skewness		-.978	-.668	-.589	-.670	-.657	-.688	-.579	-.514	-.728	-.748	-.666	-.771	-.568	-.925	-.508	-.463	.625
Std. Error of Skewness		.169	.169	.169	.169	.169	.169	.169	.169	.169	.169	.169	.169	.169	.169	.169	.169	.169
Kurtosis		.404	.219	.050	-.094	-.003	.583	.232	-.054	.115	-.118	-.489	.274	-.278	1.002	.370	-.105	.017
Std. Error of Kurtosis		.337	.337	.337	.337	.337	.337	.337	.337	.337	.337	.337	.337	.337	.337	.337	.337	.337
Minimum		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maximum		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Appendix F (cont.)

Frequencies

Statistics

		JCI_ Autonomy1 How much you are left alone to do own work	JCI_ Autonomy2 The extent you can act independent of your supervisor	JCI_ Autonomy3 The extent you can act independent of others	JCI_ Autonomy4 The freedom to do what I want on my job	JCI_ Autonomy5 The opportunity for independent thought and action	JCI_ Autonomy6 The control over the pace of my work
N	Valid	236	236	236	236	236	236
	Missing	2	2	2	2	2	2
Mean		4.59	4.60	3.88	3.84	4.19	3.59
Median		5.00	5.00	4.00	4.00	4.00	4.00
Mode		5	5	4	4	5	4
Std. Deviation		.643	.634	1.026	.976	.883	1.105
Skewness		-1.790	-1.750	-.800	-.669	-.916	-.515
Std. Error of Skewness		.158	.158	.158	.158	.158	.158
Kurtosis		4.463	4.139	.307	.105	.418	-.336
Std. Error of Kurtosis		.316	.316	.316	.316	.316	.316
Minimum		1	1	1	1	1	1
Maximum		5	5	5	5	5	5

Frequencies

Statistics

		JCI_ Feedback1 The extent you know how well you perform as you work	JCI_ Feedback2 The extent you get information from supervisor on performance	JCI_ Feedback3 Feedback from supervisor on how well I'm doing	JCI_ Feedback4 Opportunity to find out how well I'm doing	JCI_ Feedback5 The feeling of knowing if I'm doing well or poorly
N	Valid	236	236	236	236	236
	Missing	2	2	2	2	2
Mean		3.36	3.32	3.19	3.33	3.47
Median		4.00	3.00	3.00	3.00	4.00
Mode		4	4	4	4	4
Std. Deviation		1.081	1.114	1.114	1.040	1.000
Skewness		-.665	-.496	-.430	-.376	-.356
Std. Error of Skewness		.158	.158	.158	.158	.158
Kurtosis		-.060	-.345	-.541	-.350	-.364
Std. Error of Kurtosis		.316	.316	.316	.316	.316
Minimum		1	1	1	1	1
Maximum		5	5	5	5	5

Appendix F (cont.)

Frequencies

Statistics

		EWS_ Competence1 Confidence about ability to do my job	EWS_ Competence2 Self-assured about capabilities to perform work activities	EWS_ Competence3 Mastered the skills necessary for my job
N	Valid	236	236	236
	Missing	2	2	2
Mean		6.24	6.21	5.86
Median		6.50	6.00	6.00
Mode		7	7	6
Std. Deviation		1.013	1.008	1.168
Skewness		-1.812	-1.784	-1.229
Std. Error of Skewness		.158	.158	.158
Kurtosis		3.747	4.013	1.462
Std. Error of Kurtosis		.316	.316	.316
Minimum		2	2	2
Maximum		7	7	7

Frequencies

Statistics

		JSS_ Paypromo2 Raises are too few and far between	JSS_ Paypromo3 Unappreciated by what they pay me	JSS_ Paypromo4 Feel satisfied with chances of salary increases	JSS_ Paypromo5 Too little chnance for promotion on my job	JSS_ Paypromo6 Those who do well have fair chance of promotion	JSS_ Paypromo7 People get ahead as fast here as other places	JSS_ Paypromo8 Satisfied with chances for promotion
N	Valid	236	236	236	236	236	236	236
	Missing	2	2	2	2	2	2	2
Mean		4.03	2.84	3.52	3.65	3.59	3.17	3.48
Median		4.00	3.00	4.00	4.00	4.00	3.00	4.00
Mode		4	3	5	4	4	3[a]	3
Std. Deviation		1.351	1.398	1.413	1.543	1.379	1.255	1.425
Skewness		-.357	.396	-.359	-.019	-.358	-.137	-.220
Std. Error of Skewness		.158	.158	.158	.158	.158	.158	.158
Kurtosis		-.418	-.566	-.856	-.996	-.644	-.745	-.785
Std. Error of Kurtosis		.316	.316	.316	.316	.316	.316	.316
Minimum		1	1	1	1	1	1	1
Maximum		6	6	6	6	6	6	6

a. Multiple modes exist. The smallest value is shown

Appendix F (cont.)

Frequencies

Statistics

		JSS_ Benerwds1 Not satisfied with benefits	JSS_ Benerwds2 Benefits as good as other organizations	JSS_ Benerwds3 Benefit package is equitable	JSS_ Benerwds4 When I do a good job, I get recognition for it	JSS_ Benerwds5 Do not feel work is appreciated	JSS_ Benerwds6 Few rewards for those who work here	JSS_ Benerwds7 Don't feel my efforts are rewarded the way the should
N	Valid	236	236	236	236	236	236	236
	Missing	2	2	2	2	2	2	2
Mean		2.69	4.47	4.53	3.92	2.93	3.12	3.32
Median		2.00	5.00	5.00	4.00	3.00	3.00	3.00
Mode		2	5	5	4	2	4	4
Std. Deviation		1.456	1.280	1.194	1.317	1.417	1.333	1.373
Skewness		.693	-.864	-.818	-.403	.291	.219	.058
Std. Error of Skewness		.158	.158	.158	.158	.158	.158	.158
Kurtosis		-.479	.365	.506	-.286	-.844	-.648	-.717
Std. Error of Kurtosis		.316	.316	.316	.316	.316	.316	.316
Minimum		1	1	1	1	1	1	1
Maximum		6	6	6	6	6	6	6

Frequencies

Statistics

		JSS_Policy1 Rules and procedures make job difficult	JSS_Policy2 Efforts to do good job seldom blocked by red tape	JSS_Policy3 Too much to do at work	JSS_Policy4 Too much paperwork	HK_Policy5 Accounting procedures take too much time	HK_Policy6 Administrative process intefere with technical work
N	Valid	236	236	236	236	236	236
	Missing	2	2	2	2	2	2
Mean		3.98	3.30	4.14	4.11	3.81	4.03
Median		4.00	3.00	4.00	4.00	4.00	4.00
Mode		4	3	4	4	4	4
Std. Deviation		1.282	1.257	1.152	1.180	1.325	1.276
Skewness		-.054	.059	-.066	-.184	-.088	-.155
Std. Error of Skewness		.158	.158	.158	.158	.158	.158
Kurtosis		-.728	-.552	-.581	-.279	-.546	-.502
Std. Error of Kurtosis		.316	.316	.316	.316	.316	.316
Minimum		1	1	1	1	1	1
Maximum		6	6	6	6	6	6

Appendix F (cont.)

Frequencies

Statistics

Race

N	Valid	238
	Missing	0
Mean		1.8908
Median		1.0000
Mode		1.00
Std. Deviation		1.40697
Skewness		1.424
Std. Error of Skewness		.158
Kurtosis		.466
Std. Error of Kurtosis		.314
Minimum		1.00
Maximum		5.00

Race

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00 White/Caucasian	145	60.9	60.9	60.9
	2.00 Black/African American	48	20.2	20.2	81.1
	3.00 Native American	1	.4	.4	81.5
	4.00 Hispanic American	14	5.9	5.9	87.4
	5.00 Asian/Pacific Islander	30	12.6	12.6	100.0
	Total	238	100.0	100.0	

Appendix F (cont.)

Frequencies

Statistics

Sex

N	Valid	238
	Missing	0
Mean		1.42
Median		1.00
Mode		1
Std. Deviation		.495
Skewness		.326
Std. Error of Skewness		.158
Kurtosis		-1.910
Std. Error of Kurtosis		.314
Minimum		1
Maximum		2

Sex

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Male	138	58.0	58.0	58.0
	2 Female	100	42.0	42.0	100.0
	Total	238	100.0	100.0	

Statistics

Age

N	Valid	264
	Missing	1
Mean		2.97
Median		3.00
Mode		3
Std. Deviation		1.140
Skewness		.113
Std. Error of Skewness		.150
Kurtosis		-.246
Std. Error of Kurtosis		.299
Minimum		1
Maximum		6

Appendix F (cont.)

Frequencies

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Under 30	31	11.6	11.6	11.6
	2 30-39	54	20.2	20.3	31.9
	3 40-49	100	37.6	37.7	69.7
	4 50-59	58	21.9	22.0	91.6
	5 60-69	18	6.9	6.9	98.5
	6 Over 70	4	1.5	1.5	100.0
	Total	264	99.6	100.0	
Missing	System	1	.4		
Total		265	100.0		

References

Al-Faleh, M. S. (1991). *Engineers as managers: Problems and solutions.* Amman, Jordan: University of Jordan.

Allen, T. J. (1977). *Managing the flow of technology: Technology transfer and the dissemination of technological information with the R & D organization.* Cambridge, MA: MIT Press.

Andrews, F, & Farris, G. (1972). Time pressure and performance of scientists and engineers: A five-year panel study. *Organizational Behavior and Human Performance, 8,* 185-200.

Arvey, R. D, & Neel, C. W. (1974a). Moderating effects of employee expectancies on the relationship between leadership consideration and job performance of engineers. *Journal of Vocational Behavior, 4,* 213-222.

Arvey, R. D, & Neel, C. W. (1974b). Testing expectancy theory predictions using behaviorally based measures of motivational effort for engineers. *Journal of Vocational Behavior, 4,* 299-310.

Arvey, R. D, & Neel, C. W. (1976). Motivation and obsolescence in engineers. *Industrial Gerontology,3* 113-120.

Badawy, M. K. (1988). One more time: How to motivate your engineers. *Managing and Motivating Professional Performance,* 27-36.

Bailyn, L, & Lynch, J. T. (1983). Engineering as a life-long career: Its meaning, satisfactions, its difficulties. *Journal of Occupational Behavior, 4,* 263-283.

Beakley, G. C., & Leach, H. W. (1972). *Engineering: An introduction to a creative profession.* New York: Macmillan.

Bennis, W. (2000). *Managing the dream*. New York: Perseus.

Blaikie, N. (2003). *Analyzing quantitative data: From description to explanation.* Thousand Oaks, CA: Sage.

Burns, J. M. (1978). *Leadership* (1st ed.). New York: Harper & Row.

Csikszentmihalyi, M. (1996). *Creativity: Flow and the psychology of discovery and invention.* New York: HarperCollins.

Csikszentmihalyi, M. (1997). *Finding flow: The psychology of engagement with everyday life.* New York: Basic Books.

Csikszentmihalyi, M. (1999). If we are so rich, why aren't we happy? *American Psychologist 54*(10), 821-827.

Capretz, L. F. (2003). Personality types in software engineering. *International Journal of Human*

Studies, 58(2), 207-214.

Day, S. (2003). *Leadership practices of project scientists at the U.S. National Aeronautics and Space Administration.* Unpublished doctoral dissertation Fielding Graduate Institute-Santa Barbara, CA.

Deci, E. L. (1972). Intrinsic motivation, extrinsic reinforcement, and inequity. *Journal of Personality and Social Psychology, 22*(1), 113-130.

Deci, E. L. (1975). *Intrinsic motivation.* New York: Plenum Press.

Dickens, F. Jr., & Dickens, J.B. (1982). *The Black manager.* New York: Amacom.

Dryburgh, H. (1999). Work hard, play hard: Women and professionalization in engineering--adapting to the culture. *Gender & Society, 13*(5), 664-682.

Field, A. (2005). *Discovering statistics using SPSS.* Thousand Oaks, CA: Sage.

Fields, D. L. (2002). *Taking the measure of work: A guide to validated scales for organizational research and diagnosis.* Thousand Oaks, CA: Sage

George, D, & Mallery, P. (2005). *SPSS for Windows step-by-step: A simple guide and reference* (12.0 Update). Boston, MA: Pearson Education.

Goleman, D. (1998). *Working with emotional intelligence.* New York: Bantam Books.

Goodman, P. S., Rose, J. H., & Furcon, J. E. (1970). Comparison of motivational antecedents of the work performance of scientists and engineers. *Journal of Applied Psychology, 54*(6), 491-495.

Graen, G. B. (1966). Motivator and hygiene dimensions for research and development engineers. *Journal of Applied Psychology, 50*(6), 563-566.

Greenleaf, R. K. (1996). *On becoming a servant leader.* San Francisco, CA: Jossey- Bass.

Harackiewicz, J.M., Sansone, C, & Manderlink, G. (1985). Competence, achievement, orientation, and intrinsic motivation: A process analysis. *Journal of Personality and Social Pschology, 48*(2), 493-508.

Helphingstine, S. R., Head, T. C., & Sorensen, P. F. (1981). Job characteristics, job satisfaction, motivation, and satisfaction with growth: A study of industrial engineers. *Psychological Reports, 49*(2), 381-382.

Herpen, M.V., Praag, M.V, & Cools, K. (2005). The effects of performance measurement and compensation on motivation: An empirical study. *The Economist, 153,* 303-329.

Herzberg, F. (1971). *Work and the nature of man* (5th Ed.). New York: World.

Herzberg, F., Mausner, B., & Snyderman, B. B. (1959). *The Motivation to work.* New York: John Wiley & Sons.

Ivancevich, J. M., & McMahon, J. T. (1982). The effects of goal setting, external feedback, and self-generated feedback on outcome variables: A field experiment. *Academy of Management Journal, 25*(2), 359.

Jagacinski, C. M., LeBold, W. K, & Linden, K. W. (1987). The relative career advancement of men and women engineers in the United States. *Work and Stress, 1*(3), *235-247.*

Jones Jr., Edward W. (1986). Black managers: The dream deferred. *Harvard Business Review, 64*(3), 84-93.

Kantor, R. M. (1997). *Rosabeth Moss Kantor on the frontiers of management.* Cambridge, MA: Harvard Business Review Books.

Katz, R. (2004). *The human side of managing technological innovation.* New York: University Press.

Keller, R. T. (1997). Job involvement and organizational commitment as longitudinal predictors of job performance: A study of scientists and engineers. *Journal of Applied Psychology, 82*(4), 539-545.

Kopelman, R. E. (1979). Directionally different expectancy theory predictions of work motivation and job satisfaction. *Motivation and Emotion, 3*(3), 299-316.

Kotter, J. P. (1999). *John P. Kotter on what leaders really do.* Cambridge, MA: Harvard Business Review Books.

Kuprenas, J. A. (2003). Implementation and performance of a matrix organization structure. *International Journal of Project Management, 21*, 51-62.

Landy, F. J, & Guion, R. M. (1970). Development of scales for the measurement of work motivation. *Organizational Behavior and Human Performance, 5*, 93-103.

Lawler III, E.E, & Hall, D.T. (1970). Relationship of job characteristics to job involvement, satisfaction, and intrinsic motivation. *Journal of Applied Psychology,* 54(4), 305-312.

Lefkowitz, J. (2000). The role of interpersonal affective regard in supervisory performance ratings: A literature review and proposed causal model. *Journal of Occupational and Organizational Psychology, 73*, 67-85.

Lehman, M. (1963). *This high man: The life of Robert H. Goddard*. New York. Farrar, Straus and Company.

Locke, E.A, & Latham, G.P. (2002). Building a practically useful theory of goal setting and task motivation. *American Psychologist, 57*(9), 705-717.

Maehr, M. L, & McInerney, D. M. (2004). Motivation as personal investment. *Big theories revisited: Vol. 4. Research on sociocultural influences on motivation and learning* (pp.61-90). PUB LOCATION: Information Age Publishing.

Maki, D. M. (2001). Work motivators for software engineers: A case study. (Doctoral dissertation, 2001). *Abstracts International*, *61*, 4853.

Maslow, A. H. (1968). *Toward a psychology of being.* New York: Van Nostrand Reinhold.

Maslow, A. H. (1970). *Motivation and personality.* New York: HarperCollins.

Maslow, A. H. (1998). *Maslow on management.* New York: John Wiley & Sons.

Mertler, C.A, & Vannatta, R.A. (2005). Advance and multivariate statistical methods: Practical application and interpretation (3rd Ed.). Glendale, CA: Pyrczak.

Mezirow, J. (2000). Learning as transformation: Critical perspectives on a theory in progress. San Fransisco, CA: John Wiley & Sons.

Mowday, R. T., Steers, R. M, & Porter, L. W. (1979). The measurement of organizational commitment. *Journal of Vocational Behavior, 14*, 224-247.

National Aeronautics and Space Administration. (1967). *Report of Apollo 204 Review Board.* Retrieved January 30, 2007 from http://history.nasa.gov/Apollo204/invest.html

National Aeronautics and Space Administration. (1999). *NASA's full-cost initiative implementation* . Washington, DC: Office of Inspector General.

National Aeronautics and Space Administration. (2003). *Columbia accident investigation board.* (Report Vol. 1). Washington, DC.

National Aeronautics and Space Administration. (2005). *NASA full cost accounting policy.* Washington, DC.

National Aeronautics and Space Administration. (2007). *Exploring the NASA workforce.* Retrieved January 25, 2007 from http://naade02.msfc.nasa.gov/workforce/

NASA Goddard Space Flight Center. (1999). *1999 GSFC culture survey results*. New York: W. Warner Burke.

NASA Goddard Space Flight Center. (2003). *2003 GSFC culture survey results*. Washington, DC: IBM Business Consulting Services.

National Science Foundation, Division of Science Resources Statistics. (2005). *Federal scientists and engineers: 1998-2002.* Arlington, VA. (NSF 05-304)

National Science Foundation, Division of Resources Statistics. (2006). *Federal R&D funding by budget function: Fiscal years 2005-07.* Arlington, VA. (NSF No. 07-303)

National Society of Black Engineers. (2008). *Membership.* Retrieved January 30, 2007 from http://national.nsbe.org/Membership/tabid/56/Default.aspx

Scarpello, V. & Vandenberg, R. J. (1987). The satisfaction with my supervisor scale: Its utility for research and practical applications. *Journal of Management, 13*(3), 447-466.

Schein, E. H. (1999). *The corporate culture survival guide*. San Francisco: Jossey- Bass.

Segal, M. (1997). *Points of influence: A guide to using personality theory at work.* San Francisco: Jossey-Bass.

Shoura, M. M., & Singh, A. (1998). Motivation parameters for engineering managers using Maslow's theory. *Journal of Management in Engineering, 15*(5), 44-55.

Sims, H.P., Szilagyi, A.D, & Keller, R.T. (1976). The measurement of job characteristics. *Journal of Management Journal, 19*(2), 195-212.

Smith, D. R., DiTomaso, N, & Farris, G. F. (2002). Favoritism, bias, and error in performance ratings of scientists and engineers: The effects of power, status and numbers. *Sex Roles, 45*(5/6), 337-357.

Solomon, J. (1990). As cultural diversity of workers grows, experts urge appreciation of differences. *Wall Street Journal (Eastern Edition),* p. B1.

Spector, P.E. (1997). *Job satisfaction: Application, assessment, causes and consequences.* Thousand Oaks, CA: Sage.

Spector, P.E. (2006). *Industrial and organizational psychology: Research and practice* (4th ed.). New Jersey: Wiley & Sons.

Spreitzer, G. M. (1995). Psychological empowerment in the workplace: Dimensions, measurement, and validation. *Academy of Management Journal, 39*(5), 1442-1465.

Vandenberg, R.J, & Scarpello, V. (1992). Multitrait-multimethod validation of the SWMSS. *Education & Psychological Measurement,* 52, 203-212.

Vroom, V. H. (1964). *Work and motivation.* New York: Wiley.

Vroom, V. H, & Deci, E.L. (1970). *Management and motivation.* London: Penguin Book.

Walters, H. B. (1964). *Wernher von Braun: Rocket engineer*. New York: Macmillan.

Wheatley, M. J. (1994). *Leadership and the new science: Learning about organization from an orderly universe*. San Francisco: Berrett-Koehler.

Wlodkowski, R. J. (1999). *Enhancing* adult motivation *to* learn: *A comprehensive guide for teaching all adults.* San Fransisco, CA: John Wiley & Sons.

Wolf, G., London, M., Casey, J., & Pufahl, J. (1995). Career experience and motivation as predictors of training behaviors and outcomes for displaced engineers. *Journal of Vocational Behavior, 47*(3), 316-331.

Xin, K. R, & Pelled, L. H. (2003). Supervisor--subordinate conflict and perceptions of leadership behavior: A field study. *The Leadership Quarterly, 14,* 25-40.

Yukl, G. (1998). *Leadership in organizations.* New Jersey: Prentice Hall.

Zenger, T. R., & Lazzarini, S. G. (2004). Compensating for innovation: Do small firms offer high-powered incentives that lure talent and motivate effort? *Managerial and Decision Economics, 25*(6-7), 329.