CHAPTER FIVE: DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

The overall purpose of this study was to explore the meaning of implementing reform in a government research organization, and discover how these changes affect the capabilities required in workforce development. The research focused on a management approach called "Faster, Better, Cheaper" (FBC), the management framework implemented by the National Aeronautics and Space Administration (NASA) in response to Government Reinvention principles espoused by the Clinton Administration, and current efforts within the context of performance improvement efforts in the current Bush Administration that attempt to increase the efficiency and effectiveness of government organizations in their delivery of products and services to the public.

This study employed the Grounded Theory qualitative research methodology that concentrates on a central phenomenon and generates a theory from a category or "construct-oriented" approach. The investigator is the primary instrument of data collection, and inductive fieldwork rather than deductive hypothesis testing characterizes this approach. The objective is to generate a substantive-level theory that describes the practice of FBC within NASA and is "grounded" in the data collected from the organization.

The following research questions guided this study, and formed the basis for the development of categories using the iterative research and analysis cycle of Grounded Theory methodology:

1. What does FBC mean for Public Professionals in the NASA organizational environment?

2. What are the interrelationships between concepts of "faster", "better", and "cheaper"?

3. How does the technical and cultural structure of NASA influence the implementation of "Faster, Better, Cheaper"?

4. What are the required workforce capabilities to perform "Faster, Better, Cheaper" in NASA?

The literature demonstrates that there is an ongoing process of experimentation concerning government reform worldwide, and a sometimes reflexive embracement and implementation of private sector methodologies despite a lack of theoretical frameworks, to include several cost, quality, leadership, and systems methodologies. In

NASA, for example, this can be seen by former Administrator Dan Goldin's implementation of the Zero-based Review process and ISO 9000 Certification. The literature review revealed a concern among many researchers and practitioners that the nature of government service is ill served by the competing nature of several elements of the reform effort. Included in this concern are the often-competing requirements and agendas that exist between the various stakeholders in the reform process, to include taxpayers, the private sector, Congress, the Executive branch, and the bureaucratic infrastructures that exist within the various federal agencies. As a result, workforce development activities are hard to implement because of lack of policy definition and changing roles and responsibilities. For NASA as a scientific organization, these competing requirements and agendas have had serious impacts on major programs and projects, such as the former Mission to Planet Earth (MPTE) program. This program was originally budgeted for $30 billion, over 20 years, but was cut back to $8 billion in 1994 and then further reconfigured to be more politically palatable, to include a name change to the Earth Science Enterprise (Lambright, 1998). Sharply diminished resources have dictated that NASA must find a workable plan to achieve survival and stability rather than survival and growth so that a cohesive plan of scientific research can be pursued.

The theoretical sampling for this study began with recommendations for participants at the project level from the NASA Academy of Program and Project Leadership (NASA APPL). From these recommendations, interviews were scheduled with an FBC project, and these led to other interviews initiated up the management chain through NASA Enterprise and Headquarters levels. As the questions were further focused and refined on emerging data categories, participants at the Office of Management and Budget (OMB) were interviewed to add robustness to the emerging substantive theoretical framework and expand the substantive level theory described here for NASA into a more abstract and potentially useful theory that contributes to formal theory development that applies to government research and development organizations.

The iterative process of data collection and analysis began with the first set of interviews at the Langley Research Center (LaRC), comparing each of the interviews at the dimensional level, obtaining interpretations from several interviewees across the organization, and analyzing NASA documents and reports relating to the FBC process. The initial interviews focused on the development of categories, with subsequent interviews concentrating on attributes and criteria of FBC, particularly on the meaning of "better". New interview data points were reconciled with the developing structure and iteratively analyzed to saturate categories and to achieve integration and theory conceptualization.

As the project progressed, the current literature search and new literature, documents, and experience (both technical and non-technical) were applied to the evolving properties and dimensions and stimulated comparisons at the dimensional level and honed the interview protocol so that categories were saturated and additional data points were developed. The provisional categories reflected the entire gamut of capabilities, environmental factors, and behavior that are required to achieve success in an FBC organization, to include perceived definitions and interpretations of the terms "faster", "better", and "cheaper". The 29 provisional categories represented all facets of the organization, as well as the contracting and oversight environment external to NASA, including the Executive Branch, the Legislative Branch, private industry, contractors, other Federal agencies, and academia.

Findings

The descriptions and definitions of operating in an FBC environment within NASA allowed the interview participants to discuss in detail and at length their views on how to be successful in that type of work environment. The analysis of the data concerning FBC revealed several findings.

Finding #1

The first finding is that changes occurring in the Federal sector are not temporary in nature, but permanent in terms of the budget and emphasis on results and performance. Doing more with less is here to stay. Because of the politics of deficit reduction, NASA is transitioning from a scientific research organization culture to a management of science culture. The benefits of continuous improvement are achieving recognition by research managers through an emphasis by former Administrator Dan Goldin's "Faster, Better, Cheaper" mantra, leveraging advanced technologies to ensure NASA's survival while promoting a cultural shift for NASA to live within its means.

FBC was widely considered a management philosophy, but is in reality a set of desired outcomes that the organization strives for within its set of resources, providing context to Research Question One on the meaning of FBC for the Agency and its stakeholders. FBC projects address the current deficit reduction and budget cycle realities of Congress, where the more complex and expensive the project, the more likely cancellation will occur. For NASA, Dan Goldin's FBC philosophy may have preserved research priorities against operational program budget overruns.

Finding #2

The second finding also concerns Research Question One on the meaning of FBC for NASA and its stakeholders. Project personnel possess different interpretations of what FBC processes and procedures are, and how these desired outcomes interact and are balanced in the NASA project environment. At a basic level, the use of the terms "faster" and "cheaper" possess intuitively understandable definitions as applied to schedule and cost when applied to project outcomes. The term "better" is another matter entirely. It depends on the context of the functional environment where it is used, and at what level of the organization it is used. Operational personnel could equate "better" with a successful mission, while scientists could equate it with more data volume and higher data quality. Engineers could equate "better" with increased technical performance, while process personnel could claim that increased efficiencies and effectiveness of business processes would mean "better". Managers at higher levels of the organization may define "better" differently than project team members due to differing metrics, politics, and requirements.

Regardless, the term "better" connotes both continuous improvement and revolutionary improvement in both the research and mission operations world, and in NASA is tied to the use of improved technologies. FBC possesses a particularly pragmatic view of the purpose of a Federal R&D organization, spreading risk across several categories of smaller efforts that realize a quicker return on investment in terms of science or improvements in operations that are transferred to the private sector, as well as to other components within NASA, and in the long run achieving stability for programs and projects in a volatile political environment.

One of the missing ingredients in the FBC methodology is the learning of lessons provided by research, and how these lessons are integrated and applied into engineering for manned operations, to include allowing time for basic research activities to cycle back for improved safety. In discussions concerning the meaning of FBC, the components of FBC are seen as desired outcomes gained by achieving efficiencies and increased effectiveness by focusing on smaller missions, incorporating advanced technologies, decentralizing program and project management to the Centers, and creating exciting visions and roadmaps, specifically oriented to the research side of the house. In particular, these advanced technologies are applications of science that were almost unthinkable only a few years ago, such as the rapid development and maturity of information technology, the development of collaborative communications technology and virtual environments and simulations, and the maturity of computer-aided design (CAD) and related tools and techniques.

Finding #3

The third finding covers FBC requirements and constraints and addresses Research Question Two. Ideally, FBC is achieved through balance and optimization of cost, schedule, technical performance, and customer satisfaction in an environment of safety and constrained resources. Risk applies to the explicit differentiation of the research project portfolio across the entire Agency. The type of mission plays a significant role in the application of the FBC management philosophy. For space science, earth science, and aerospace science, risk is balanced against the potential for increased volume and fidelity of scientific data, while manned missions require safety considerations to be primary, negating any efforts that are perceived to compromise safety within the context of a historic and rigorously defined and applied system. This emerges as a key difference in the application of FBC in operations versus research communities within NASA, and addresses the interplay between FBC elements.

The activity of comparing to an internal or external baseline can be critical to the definition of "better", whether it is a previous effort, the effort of a competitor, or comparison to customer expectations of what is possible to accomplish. For example, the Mars Lander project sacrificed the capability to provide telemetry data to remain within cost requirements, thus making it impossible for any subsequent missions to learn from the failures of this particular mission. The explicit outcomes of learning from the performance of this spacecraft were not prioritized as an essential mission element. These comparisons can only be made if the relevant criteria are collected during internal testing and development, during the mission, and documented, an active effort to build in metrics that monitor processes, outputs, and outcomes, regardless of their origin. More frequent missions require better lessons-learned so that success is replicated and errors are not repeated. This gaining of incremental knowledge allows for information to fill more and more of the unknown elements, and allows for the organization to gain efficiencies in cost, schedule, and quality.

The matching of FBC tools and techniques to the appropriate projects is a key element of managing the risk, especially in terms of unmanned versus manned systems. These FBC tools and techniques may well be very conservative incremental process improvements where crew safety is involved, as opposed to more radical risks that gain potentially big payoffs in scientific data in unmanned missions. Innovation can be achieved without sacrificing safety, but this is not currently done since the Agency does not manage programs and projects as a portfolio prioritized by risk, with a clear discussion of expectations and boundaries between projects and management.

Finding #4

The fourth finding is that NASA may not be organized to easily apply the management philosophy of FBC, addressing Research Question Three. At the top, senior management does not seem willing to formalize the philosophy of FBC, resulting in miscommunication of the FBC philosophy and methodology throughout the organization. From the perspective of NASA public professionals in research programs and projects, the best parts of this scientific research organization are sometimes sacrificed to achieve management objectives in higher priority manned operations in an environment of cutbacks and downsizing, and often these sacrifices are not explained nor fairly distributed. Because of the bureaucracy, public professionals in NASA may not be able to engage in proactive behavior that could result in improved trade-offs and would result in improved policy development, implementation, and evaluation that would better balance all priorities. These explicit discussions do not take place as a result of fear, miscommunication, parochial cultures and agendas, or simply because no one is trained on how to conduct these types of activities.

Many management hierarchies will just hire someone else if a person says “no” to management challenges. That is the fear that many project managers have, and it exists in NASA. The key is a clear, organized case that contains options that are palatable and that achieve mission requirements, a very explicit conversation defining the expectations and constraints of the program or project. The culture does not seem to support this, and part of the difficulty in implementing FBC may be that a change needs to occur in the process that allows for a more accurate determination of requirements, constraints, and innovation to occur, including contributions from basic research and previous missions. This freedom to take risk is a difficult thing to achieve and maintain in an organization that exists in the public spotlight, and is held accountable for the spending of public money.

The parochial nature of the Centers sometimes prevents the efficient importing of technologies and methods that will assist NASA in meeting its responsibilities, a willingness to learn from others. This reflects the acceptance and inevitability of trade-offs in prioritizing science in an environment of decreased resources, where strategic partnerships and priorities are critical towards realizing successful outcomes. The lessons learned from these partnerships are essential across the entire organization. Trade-offs are often made through use of technologies, possibly from academia and the private sector, that are mature enough to achieve the mission objectives without increasing risk of mission failure, thereby driving down costs because of the increased gains in effectiveness and efficiency by the use of that technology. These margins defined by cost, schedule, technical performance, and customer satisfaction can be exploited by using the right technology, where internally developed or imported from outside the organization.

Finding #5

The fifth finding is that there are general competency categories that are necessary for FBC to be effectively and efficiently implemented. The five dimensions of workforce capability directly address Research Question Four. One capability covers public service orientation, work activities characterized by desire to contribute to the country through work at NASA and the challenging nature of the work environment. This is a differentiation that is a unique motivation and source of pride for NASA public professionals.

Leadership of mixed private and public sector teams addresses leadership over two very different philosophies: making money and public service. Leadership behaviors that engender trust, integrity, and loyalty emerged as critical elements for leaders of mixed teams, just as they do in exclusively public or exclusively private sector teams, but the lack of a workable leadership model across NASA contributes to many definitions of desired leadership capabilities at each Center and for each Enterprise, especially when married to required organizational roles.

The political situation across NASA Centers does not allow Agency-level leaders to develop, manage, and lead effectively, due to the autonomous nature of the Centers as a historical artifact of NASA cultural development that often is difficult to change. This leads to parochial behavior that can sacrifice overall Agency science initiatives, as well as result in different views of what it means to be a good leader for each Center. NASA leaders may not be cognizant or committed to overall Agency goals and objectives, thus unable to achieve the necessary buy-in and insight or oversight activities for the program or project that they lead, which may compound the issue of the NASA structure encouraging the creation of parochial leaders, concerned about the survival and prosperity of their particular Center as opposed to the survival and prosperity of the overall Agency as a whole and the achievement of National goals and objectives.

Acquisition capability addresses the knowledge, skills, and abilities involved in obtaining products and services from the optimal source in terms of best value, to include public, private, and academic sources. The structure and culture of NASA may not support the espoused philosophy of FBC in many instances. This is in contrast to oversight elements indicating that smart risk should be encouraged due to the emphasis that the restrictions of a tight Federal budget are a key consideration in applying a successful acquisition strategy, and there is now a fundamental emphasis on achieving practical results. Because of this, acquisition capability needs to emphasize low-cost and near-term gains to survive in the current budget environment, as well as leveraging private-sector partnerships.

The reasons for improved acquisition skills are many. The requirements of the science community are historically second behind operational concerns. The transition to FBC was in part a way to save the research capabilities of NASA in the face of rising manned space flight operational costs, preserving research capability for the Agency. Research as an activity is required to compete just like everyone else in the organization, sometimes putting at risk the best parts of NASA's scientific research capability. The management of science is emphasized over the science, which may not be "faster", "better", or "cheaper". The short-term focus of FBC theoretically ensures improved budget stability for research projects in the face of rising operational costs, but the cost growth of operational missions sabotages the implementation of FBC projects by simply occupying a higher Agency priority, taking money from research programs whenever it is deemed necessary.

The overall stability of the Agency's budget also emerges as a critical concern for research programs, since research is a notoriously difficult thing to budget for, especially in an unstable budget environment. Critics inside and outside of the Agency are advocating a number of initiatives that strengthen the ability of NASA to become a premier research organization again. These include focusing on the core competencies of the Agency, forming partnerships and outsourcing with private industry, strengthening acquisition capability within its project manager community, and moving to full-cost accounting. Stewardship of the public dollar requires expertise and technical capability from committed public servants, but the government in essence is relying on buying technical capability rather than maintaining it in-house at NASA, requiring a systematic review of existing and desired capabilities, and how these capabilities are integrated with outside resources to accomplish desired goals in the National interest. If NASA can reprioritize its project portfolio and nurture better buyers within the Agency, it may be able to achieve the goal of "Doing More with Less".

The dimension of "Critical and Creative Thinking Skills" manifests itself in the required knowledge, skills, abilities, attitudes, and values that result in a more accurate representation of problems, situations, and opportunities, and allows for the exercise of mechanisms that promote and achieve innovative solutions. This applies to both sides of the problem-solving equation, where critical thinking provides the rules to define the requirements of the endeavor in defining the boundaries, and creative thinking allows the team to see how those boundaries can be eliminated or mitigated, intimately tied to managing risk. Another way to view this capability is in terms of convergent and divergent cognitive skills. For the management of science in a Federal bureaucracy, all levels of management should be aligned to the management philosophy of the organization, not just at the top. The temptation to be a hero seems to infiltrate FBC projects, where smart people are expected to overcome major challenges without critical and accurate evaluation of potential risk factors.

The final workforce development dimension is "Technical Capability", the expectation that NASA public professionals possess a high degree of technical knowledge and skills, enough to not only provide oversight, but to add value to the program or project by providing insight as a result of their knowledge and experience. This is closely related to the Leadership of Mixed Public/Private Sector Teams. Unfortunately, NASA cannot provide the cutting-edge technical expertise by itself. It needs to leverage external resources so that its workforce maintains a sharp technology and engineering edge, especially if it wants to refocus itself into being a premier research organization.

Discussion

The drive for government reform is steadily gaining momentum as market efficiencies from the private sector are introduced into government environments at all levels. As these efficiencies are introduced, new public management (NPM) and other reform advocates are beginning to grapple with the critical managerial, workforce, and organizational issues that must be addressed to successfully transfer private practices into public organizations, and to address the nature and roles of public service by Federal employees in this type of environment. The foundation of government work and public service is being transformed by the changing role of government, public perceptions and demands for products and services, and the increasing complexity, integration, and overlap of government agency missions. Neglected in some instances of this discussion is theory development addressing the public sector that allows for a better understanding of how public and private sector organizations are similar and different, how the public interest is addressed and protected, the required capabilities of public professionals to operate effectively and efficiently in such an environment, and the effects that various stakeholder actions have on government organizations that are expected to provide products and services, many that grow from ambiguous policy definitions and politically-driven motivations.

Several public sector tools and methodologies have been imported from the private sector to achieve narrowly-defined results in the delivery of government products and services, possibly independent of issues that surround many of the Federal organizations involved in the setting of public policy and implementation of programs and projects. Many of these government implementations have anecdotal evidence and case studies that support improvements within the narrow scope of delivery, but these improvements may prove to be transitory and temporary fixes that stand little chance of providing long-term improvements in the absence or neglect of public policy concerns, especially in scientific and technological research and development. In addition, the required organizational support and policy adjustments may not occur for workforce development to allow lessons to be learned so that replication of successful scientific and engineering programs and projects can occur.

The managerial philosophy of "Faster, Better, Cheaper" was the adopted approach for the National Aeronautics and Space Administration (NASA) during the years of the Government Reinvention effort of the Clinton Administration. NASA Administrator Daniel Goldin began the FBC policy initiative in 1992 to accomplish more frequent, less expensive missions to deliver better science and technology so that NASA would regain and maintain its position as a premier scientific research organization. As a result of this policy initiative, NASA has focused on smaller missions, incorporated advanced technologies as feasible into programs and projects, decentralized by shifting program and project responsibilities to the Centers, and constructed exciting visions and roadmaps towards future missions (NASA Strategic Plan, 1998).

The preservation and success of several unmanned scientific research and development missions in the face of mounting costs in the manned exploration arena supports the perception that FBC has achieved at least some of its objectives, and has resulted in a large positive impact on NASA. There is evidence that the FBC approach has enabled NASA to expand unmanned scientific missions, especially in the Space Science and Earth Science Enterprises, despite the potentially crippling budget realities involved with support of the Human Exploration and Development of Space operations of the Space Shuttle and the International Space Station programs. The argument can be made that Administrator Goldin gained credibility by forcing NASA to internally institute cutbacks in programs, thus maintaining control of where the reductions occurred, and could point towards FBC as a method to achieve further cuts in the future through new technology. The interview data supports the premise that FBC is a pragmatic response to achieving results in a resource-constrained environment. The achievement of "better" results from scientific programs and projects has occurred in several missions that were developed and implemented using the FBC approach, to include the $250 million Mars Pathfinder mission that significantly improved on the original Viking mission costs of $2 billion.

FBC projects have resulted in more research missions in less time, with greater quantity and quality of scientific results enabled by leveraging advanced technologies. Projects within NASA have increased three-fold, and science stakeholders are pleased with this emphasis, since historically the manned component of NASA has received the lion's share of resources. However, there have also been high-profile FBC mission failures (Mars Polar Lander and Deep Space 2) that have been attributed in some instances to the lack of an established definition of FBC policies and procedures to guide implementation. This becomes apparent in looking at the definitions of FBC that emerge from the various interviews, and how inefficiencies in the bureaucratic structure of NASA and political issues have prevented effective implementation of FBC across the entire Agency.

Document analysis of several mission failure board investigations support the findings that project managers possess different interpretations of what FBC processes and procedures are, what constitutes prudent risk, and that the overall organization lacked a definition of what competencies and capabilities are required to recruit, develop, and maintain practitioners of FBC research programs and projects. Table 4, Reasons for Selected Spacecraft Failures, summarizes overall causes of spacecraft projects, where the causes seen to be systemic. In this environment, FBC has to battle organizational and cultural factors that inhibit success, such as miscommunication, inadequately trained staff, and disregard for established procedures and best practices. Regardless of these issues and the absence of formalization of FBC processes and procedures, the pervasiveness of discussions within the organization about FBC illustrates the impact that the policy has had on NASA at all levels. If these failures of FBC were viewed in the light of reasonable increased risk due to acceptable and defined factors such as the use of new technology or new methods, perhaps these failures would be more acceptable and forgiven. However, the documents and interview data point towards management failures due to lack of staff capability, inadequately defined management processes and procedures, and lack of critical technical insight, communications, and coordination that serves to offset narrow budget and schedule concerns.

As a reflection of both successful and failed implementations of FBC, several clear characterizations of required capabilities needed in an FBC environment have emerged from the interview data. One of the most important but least understood concepts is public service orientation, encompassing values and attitudes that motivate public professionals to innovate and proactively achieve tangible results while achieving value through the application of public resources. It can be argued that this public sector orientation is what makes public professionals unique, since they are charged with ultimate responsibility for securing the public interest and stewarding the public dollar. A lack of understanding of Federal policy aims and basic budget politics handicaps public professionals in providing for a stable environment for project implementation, as well as weakening the project team by not providing for a consistent vision of project success and how that success will assist others that will follow in building on that success. The public professional must also be sensitive to understanding the differing motivations between the public and private components of the project team, and how these motivations manifest themselves in team behavior.

The interview data reveals that the nature of the work environment in NASA is a motivator, in conjunction with an overall desire and pride in public service. Some things cannot be accomplished without the deep pockets of the Federal government to underwrite the costs and risks, and some of these efforts are not as prevalent in the private sector at the same level of effort and scope, despite the fact that contractors are usually responsible for the implementation of these large research and development programs and projects. The danger of simply applying narrowly focused business processes and tools is that streamlining of bureaucratic government institutions and their processes occurs, but the fundamental nature and spirit of public service and personal achievement is damaged or altered. Public professionals resist acceptance of these business processes and tools because they focus on efficiency, not on good public policy. For Federal research and development organizations, it is important to clearly understand the motivations of their public professionals and the reasons why they enjoy serving, as well as the factors that keep them satisfied and fulfilled in their functional disciplines. The interview data indicates that the work content and service to country were key motivators.

Based on the program and project workforce and their motivations, one issue is how NASA personnel perform as leaders of mixed public-private sector teams, since the majority of implementation is achieved by contractors. The current Administration is promoting outsourcing even more of the work accomplished by Federal agencies. Leadership becomes the mechanism through which priorities are established and work is accomplished, and the data indicate that NASA personnel realize they must grow to fulfill the role of technical leaders in a mixed public-private environment, providing technical insight to the research and engineering project and ensuring that effective stewardship of the Federal dollar is achieved. To provide this type of leadership, technical expertise and experience is required to reinforce the exercise of leadership skills. For example, Bozeman and Wittmer (2001) emphasize the importance of defining the technical role (allocation of responsibility for research performance between government and industry) and technical range (capability along the spectrum of research and development performance) that is performed by the public and private partner in a Federal laboratory and industry partnership, and how this definition is critical to the technical strategy that underlies the research and development partnership.

In another view of public professional leadership, Balk and Calista (2001) emphasize that in the new public sector environment of transformation and reform, neutral competence is not a useful guide for bureaucratic action, classic bureaucratic rule-based relationships are losing their utility, government agency structural permanence is less probable, and that dutiful responses to political direction are decreasingly probable. In Balk and Calista's view, the core issue in reforming government is that of reshaping existing patterns of power and influence that allow for public professionals to engage in increased risk taking in supporting the public interest.

Balk and Calista's formulation impacts directly on the issue of workforce development of public professionals, and in defining what capabilities are needed to function effectively in this type of environment. This is a more encompassing conceptualization than the Entrepreneurial Government approach espoused by Osborne and Gaebler (1992). For example, the researchers use Simon's (1946) "proverbs of administration" and suggest that the integration of facts (visible) and values (desirable) are more important than their separation. The researchers claim that the centrality of facts over values create paralyzing arguments that do little in clarifying and enabling public professionals to become proactive in their actions and to assist in creating their identity within the government context. NASA personnel now exist in the new world of constrained resources and greater expectations, and this points to a need for clarifying leadership theory in the public sector to define how these desired proactive actions can occur under potentially ambiguous policy conditions and budget turbulence.

In this integrated environment, theories such as street-level leadership (Lipsky, 1980) can be applied to better understand the dynamics of working in a public sector organization. It can be viewed that public professionals apply discretion in determining how public policy is implemented at their level of responsibility, where this ability and expectation by the public for street-level bureaucrats to exercise discretion and judgment amounts to leadership behavior, but Lipsky specifies that the values that drive this behavior is the key. If the values that drive this behavior are important, it is surprising that NASA does not address the development and nurturing of public service orientation that may characterize leadership behavior, color critical and creative thinking towards policy implementation, ensure ethical determination and application of acquisition capability, and create a solid basis for providing technical insight appropriate to the defined roles performed by NASA, academia, and industry in a science research and development project. The capabilities that have emerged from the interview data may mitigate the intervening conditions in the NASA substantive-level theory that prevent the successful implementation of FBC missions and can allow for better replication of the efficiencies achieved in these program and projects. The interviews reveal recognition of the nature of risk acceptance for public professionals and how this risk needs to be appropriate to the nature of the project.

It is this very concern for values that have motivated researchers to develop more robust theoretical frameworks that address the nature of the workforce in the public sector. For example, the framework for government professional action proposed by Balk and Calista (2001) dovetails with Lipsky's street-level leadership theory by proposing a three-dimensional model that provides the scope of action (SOA) defined by three decision contexts of Justification (policy or intent), Implementation (operations or action), and Verification (evaluation or results) represented as linear attributes that possess unique properties.

- Justification operates from low to high ambiguity, based on uncertainties such as differentiated political constituencies, limited abilities to predict resource expenditures, and ill-specified, paradoxical policy content.

- Implementation varies from low to high incongruity and increases as the difference between stated purposes and capacity to fulfill intentions increases.

- Verification difficulties increase as reliability and validity of data decreases in conjunction with the suitability of methods that compare expectations and results.

Balk and Calista (2001) suggest that the smaller the SOA, the more likely that the policy will produce clear statements of intent, that operations will create higher quality outputs at lower cost, and that evaluation will uncover robust relationships between intent and the results of operations. In government organizations, this clean function is difficult to achieve due to value differences in policy definition and policy development that trickle down through operations and evaluation activities. The researchers emphasize that the analysis of the visible (factual) against the desirable (values) is the crux of what public professionals at street-level accomplish in balancing agency requirements to their professional self-respect and integrity. In the view of street-level leadership, this has clear implications for the freedom of movement that public professionals can employ in implementation of public policy initiatives within the existing power and influence centers of the organization. For NASA, the interview data clearly shows that NASA Center concerns take priority over Agency-level concerns, and that the preservation of NASA Centers and internal competition for programs and projects leads to many of the inefficiencies present in the Agency. In addition, better critical and creative thinking skills are needed to effectively reduce this gap between the policy definition and policy implementation.

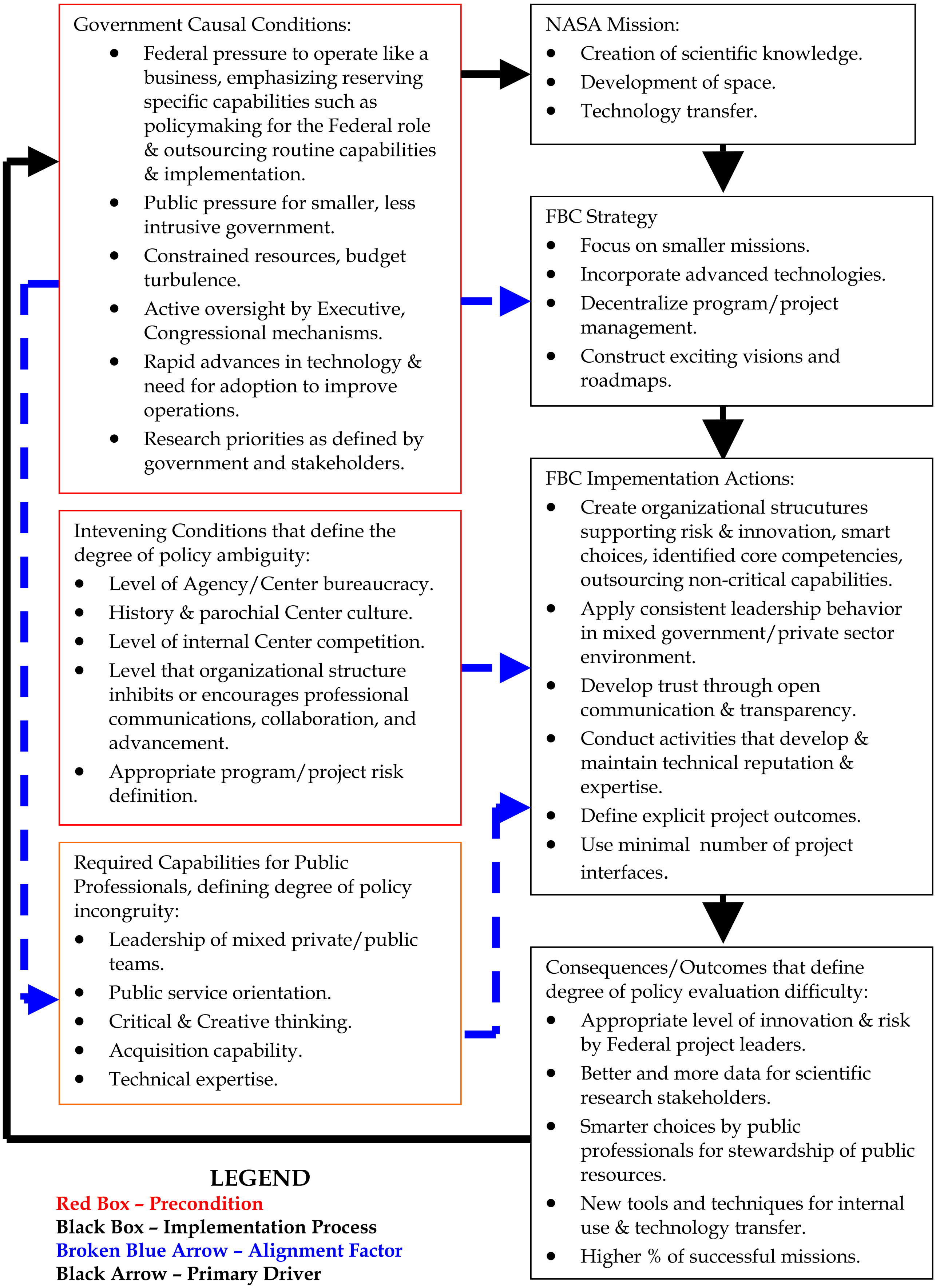
It is not difficult to understand the threat to control and power in NASA that certain Agency-level public professionals could represent if they are allowed to influence the preexisting intervening conditions of the NASA model. This shift hits at the heart of NASA's transition from a Procedural Bureaucracy to the Corporate Management and Market Bureaucracy models as defined by Considine and Lewis (1999). The spirit of Lipsky's and Balk and Callista's models are consistent with Considine and Lewis's Network Model that emphasizes collaborative mechanisms between government managers, stakeholders, and target populations, promoting interdependence as an overall force. The Network Model may serve as an ideal conceptualization for street-level leaders to exercise the smaller SOAs emphasized by Balk and Callista that meet the original intent of broader Federal policy within the context of these smaller interdependent networks.

As government agencies and their missions become more interdependent, the program and project environment becomes more complex, and resources are increasingly constrained, public professionals will need improved capabilities and understanding that addresses several capabilities. According to the interview data, these capabilities that are needed for FBC in NASA concern the nature of public service, leadership of mixed public and private sector teams, critical and creative thinking, and acquisition capability to achieve the expectations of better results and outcomes in a Federal research environment. These capabilities may contribute significantly to defining and interpreting public policy, implementation of public policy, and evaluation at all levels of performance in a government environment, as well as better integrating values and facts so that government objectives and personal attitudes may coexist productively.

NASA Substantive-Level Theory

Based on the analysis of the data and the previous discussion of potential complimentary theoretical concepts, a substantive-level theory (Figure 2) was constructed for NASA. This theoretical infrastructure addresses the key workforce development capabilities that were discovered, as well as causal elements in the government environment that are creating the need for management philosophies like FBC. It may not be seen as in the best interests of the existing points of power and influence existing in NASA to have public professionals implement FBC strategies that

Figure 2: NASA FBC Substantive-level Theory



exclude Center interests and priorities, since programs and projects are the bread and butter for their existence, paying the bills, expanding the workforce, creating new infrastructure such as wind tunnels and laboratories, and expanding their influence over aerospace policy through their political representatives.

The substantive-level theory contains a set of causal conditions consistent with the New Public Management (NPM) philosophy and other elements of government reform efforts. These causal conditions are characterized by a business approach to government organizations that aligns with the public's preference for a smaller, less intrusive government, enforced by active oversight by the Congressional and Executive branches, and an entrepreneurial approach to service that emphasizes discretion and decision-making at the level of product or service delivery. The competing priorities for fixed Federal resources drives budget turbulence, and rapid advances in technology achieves the twofold impact of faster communication of information across all levels of society and the obsolescence of public policies that cannot keep pace with scientific discovery and application. These conditions impact at the strategy level of NASA in the form of independent business initiatives aimed at improving processes and outcomes, bypassing the mission requirements for the organization and the public policies needed to achieve these missions. NASA possesses missions that define it as a scientific research organization that focuses on the development of space and innovation of new technologies that can be transferred to the private sector.

These conditions also influence the types of capabilities that public professionals should possess to implement FBC, consistent with government reform initiatives. In applying Balk and Calista's model (2001) to the NASA model, the greater the extent of possession of these skills, the less should be the degree of public policy incongruity present at the program or project level. The lower level of incongruity leads to the FBC desired outcomes of increased innovation, more and better scientific data, smarter and better-informed choices by NASA project leaders in decision-making situations, more and better technology transfer to critical aerospace industry components, and an increased percentage of successful missions.

To better achieve the desired outcomes, NASA has also chosen to focus on smaller programs and projects that leverage advanced technologies and lend themselves to a decentralized management framework that could contribute to exciting new visions in the Enterprises of Space Science, Earth Science, Aerospace Technology, and Biological Studies. Conspicuously absent in this group is the Human Exploration and Development of Space Enterprise, where safety blurs the distinction between smart risk and dumb risk, and perhaps a more traditional view of evolutionary change and use of mature proven technologies is the norm.

Implementation guidelines that emerged from the data cover clear implementation actions required for FBC to succeed, to include innovation, clear risk signatures, requirements definition, use of appropriate technologies, leveraging appropriate external capabilities, consistent leadership, open communications, presence or acquisition of technical expertise, explicit outcomes, and an optimized level of program or project interfaces. This is mitigated by intervening conditions that work against these optimal implementation actions and contribute to the degree of policy ambiguity that exists, to include bureaucracy, history and culture, internal competition, closed communications, lack of advancement and professional growth opportunities, and appropriate risk definition for the defined research mission. The quality of the implementation actions themselves are affected by the level of possession of capabilities by street-level leaders, where the degree of policy incongruity is reduced by public professionals that are motivated by a solid public orientation, that use effective leadership methods to influence both public and private sector team elements, that accurately define stakeholder requirements and innovate through critical and creative thinking skills, that apply legal and appropriate acquisition tools to create products and services, and possess a level of technical capability that allows for insight from the Federal level to be provided for complex scientific and technical research programs and projects.

The interview data on the definitions of "better" directly address the difficulty in defining the degree of policy evaluation. These consequences and outcomes cannot be effectively judged if there are no criteria to judge them. Successful FBC projects may be due to chance, may be caused by better leadership within those particular programs and projects, could be the result of more management protection or emphasis, might be the luck of the draw in selecting better contractors, or may simply be a result of smarter and better decisions by project personnel. Since the management philosophy of FBC was never formally defined, and the policies, procedures, and organizational requirements were never specified, the performance measures for increases in research effectiveness and efficiency could not be created. This substantive-level theory of FBC may serve as a starting point to begin the audit trail on the phenomenon of FBC.

Conclusions and Recommendations

There are several conclusions and recommendations that can be drawn from the findings in this study. Despite several noteworthy successes for FBC projects and the intuitive support for the management philosophy by NASA personnel at all levels of the organization, the current organizational structure can be better optimized for supporting the desired levels of innovation and proactive participation by public professionals needed to consistently achieve the desired results of an FBC environment.

The first recommendation is to structure FBC as an Agency management public policy, defining its meaning, tools, processes, procedures, and dimensions, to include how FBC impacts scientists, engineers, process and operations, and management and administration. This would be based on an overall understanding of the overall Federal project environment and how FBC addresses the motivation to do more with less. This should be adapted to the needs of each Enterprise and would be achieved through balance and optimization of cost, schedule, technical performance, and customer satisfaction in an environment of safety and constrained resources. The type of mission plays a significant role in the application of the FBC management philosophy and emerges as a key difference in the application of FBC in operations versus research communities within NASA. The institutionalization of FBC would address the interplay between FBC elements for each Enterprise, ranging from the gaining of incremental knowledge to more radical risks that gain potentially big payoffs in scientific data. This overall process would reduce the level of miscommunication and would enhance deeper understanding of programs and projects among all mixed-team components.

The second recommendation is to use the process of FBC to identify, develop, and implement organizational processes and structures that address various programs and projects differentiated by risk, innovation, and basic public policy aims, and allows NASA public professionals to prioritize and manage these technical programs and projects as a portfolio. This would allow for a smaller professional cadre of public managers to provide improved oversight and insight to sets of programs and projects.

The third recommendation is to develop, define, support, and coordinate a system addressing specific Center contributions to cross-Agency core NASA capabilities, and develop a reasonable outsourcing plan for non-critical NASA capabilities. This would allow the Agency to focus on strengths that would support a smaller set of technically proficient NASA public professionals managing a prioritized portfolio of programs and projects.

The fourth recommendation is to create and enforce a workforce development model that addresses working in an environment of constrained resources. Validation of the workforce capabilities of public service orientation, leadership of mixed teams, critical and creative skills, acquisition capability, and technical expertise discovered in this research project would need to occur for each Center within the context of their efforts in their Enterprise. This includes the definition of a leadership model appropriate to the science and technical role being performed by NASA and industry partner teams across all levels of NASA, focused on the public service role and geared to development of trust and transparency through promotion of open communications and professional collaboration inside and outside of the Agency. The maintenance of hands-on technical reputation, capability, and expertise could leverage public and private partnership resources in a personnel-exchange environment. Acquisition capability would focus on requirements definition, risk management, and contracting and procurement issues that stress innovative solutions, improving discussions of explicit outcomes based on risk signatures and realistic expectations. Critical and creative skills would be individual and team-based, allowing public professionals to apply processes and procedures in a proactive fashion appropriate to the priority and complexity of their portfolios.

The final recommendation is to use information technology and collaborative processes to break down the walls between Centers to efficiently import and export technologies and methods that will assist NASA in meeting its public service responsibilities and promote a willingness to learn from others. Lessons learned from strategic partnerships are key to replicating successful outcomes. These trade-offs in the use of technologies developed from basic research in NASA, academia and the private sector need to be taught across the organization so that the appropriateness and risk of using these technologies can be made explicit.

The transformation of governmental agencies is moving forward, and NASA public professionals recognize the importance of adapting to new political and business realities. The lessons of FBC have not been lost on NASA, the government oversight organizations, and industry. All stakeholders recognize the benefits that have been delivered through FBC, but it is important to preserve the spirit and intent of implementing FBC. FBC has encouraged NASA public professionals to innovate and exceed expectations, but this means that the conditions of FBC must be addressed. It is not simply a matter of continuous improvement at the organizational and personal levels, but a defined management philosophy and set of desired outcomes that supports desired workforce behavior through defined roles and responsibilities, proven tools and techniques, explicit outcomes, open communications, development of required capabilities, and an organizational infrastructure that differentiates and prioritizes its science and engineering programs and projects, some based on discovery, some based on the practical needs of its customers, but all justified in a strategic portfolio that supports the public interest.

Government scientific research organizations, in an ideal world, would have immutable priorities and budget stability to pursue unambiguous public policies that result in better research outcomes for all of NASA's customers. This is rarely the case. Government organizations reach policy decisions that proliferate in ambiguity, as do incongruities in operations and difficulties in evaluation (Balk and Calista, 2001). This environment clarifies the need for the possession of improved policy analysis and interpretation capabilities, where public professionals can apply their skills in implementing a strategic science and engineering portfolio of projects. Realistically, culture and politics will always influence the implementation of research programs and projects in NASA, but this can be mitigated through the identification of core competencies for each Center, and establishing the horizontal linkages that allow for professional affiliation and communications to occur between NASA personnel across all Centers.

There are several areas that lend themselves to future research. One is the issue of defining how Federal research organizational structures can accommodate the increased risk taking and proactive behavior of public professionals that is required for more effective and efficient policy development, implementation, and evaluation. Quantitative instruments that measure the degree of policy ambiguity, policy incongruity, and degree of evaluation difficulty would assist scholars and practitioners to better understand the dynamics involved for public policy implementation. An extension of this research would be improved identification and definition of the factors affecting implementation of public policies such as FBC, and which factors improve or worsen implementation.

Another area is the nature of performance in a mixed public and private sector environment, its characteristics, and the nature of influencing behavior from public professionals in a project environment that also contains private sector team members. Empirical studies are needed to establish the relationships between technical expertise, critical and creative thinking, public service orientation, leadership of mixed teams, and acquisition capability and the desired outcomes of a research organization

Finally, research is needed in relating the substantive-level FBC theory of NASA to other science and research organizations, as well as integration into existing public policy theoretical constructs such as the Professional Action in Government framework of Balk and Calista (2001) and Lipsky's Street-level Leadership model. The nature of public sector orientation capability needs to be better defined and compared and contrasted to the existing literature concerning motivation and organizational commitment in the public sector, which itself is not conceptually well defined (Moon, 2000).

APPENDIX A: HISTORICAL PERSPECTIVE

Introduction

The National Aeronautics and Space Administration was created during a period when America doubted her ability to withstand an assault from the threat of Communism. Missiles and weapons of mass destruction were being developed and fielded against America and her Allies, aggressive rhetoric was published and spoken by major opposing world leaders, and armed revolutions were occurring around the world. There was also a new threat from within: spies passing atomic secrets to foreign governments, ideological arguments claiming the superiority of Communism over Democracy, and the disruption of normal everyday life and trust through rational and irrational suspicion and fear of our own citizens.

The Early Years

It is not so hard to imagine since our recent tragedies on September 11, 2001 how powerful it is to go through a true national crisis that possesses the power to unite the America in a consensus of action against an overwhelming threat to national interests. On October 1957, the Soviet Union achieved the successful launch of Sputnik I, this success being achieved by a Communist country that emerged as the greatest competitor of the United States during the Cold War period. The steady "beep beep" signal immediately betrayed the overall sense of American technical and educational superiority that existed before Sputnik. Interestingly, a Rand study conducted in 1946 had suggested that a satellite launch would probably produce repercussions in the world comparable to the explosion of the atom bomb (Burrows, 1998, pp. 127-128). The creation of NASA can ultimately be traced back to this singular event.

In reality, the United States was in relatively good shape on the education and technology fronts. The National Advisory Committee on Aeronautics (NACA) had been formed as a response to another perceived national crisis in 1915 when the United States became aware of aeronautical developments and applied research occurring in Europe as a result of the pioneering efforts and influence of Orville and Wilbur Wright's first powered controlled airplane flight in 1903 at Kitty Hawk, North Carolina (Bilstein, 1989, p. 2). The onset of World War I in Europe spurred the creation of NACA, whose purpose was "to supervise and direct the scientific study of the problems of flight, with a view to their practical solutions" (Bilstein, 1989, p. 4). One point that needs to be emphasized is that military imperatives drove the creation of NACA, even though the peacetime benefits of scientific research were emphasized in its creation. This would be a consistent pattern in national efforts in aeronautics and space travel throughout modern history and it persists today in the modern successor to NACA.

NACA contributed many important advances in the areas of aeronautics, as evidenced by the rapid progress of civil and military aviation and research through the 1920s and 1930s. Airmail service emerged, airline travel began and grew, modern airports were developed, modern radio communications improved, the professions of pilotry and aircraft construction were standardized, and Charles Lindbergh traveled solo by airplane from New York to Paris. However, rocketry was not one of NACA's original specialties (Bilstein, 1989, p. 12). That was reserved for pioneers such as Robert Goddard of the United States, Hermann Oberth of Germany, and Konstantin Tsiolkovsky of Russia, who together represent Rocketry's three giants and who were all inspired by Jules Verne and his books *From the Earth to the Moon* and *Around the Moon*, where Verne sought to convince the public that science, technology, and nature were now and forever inseparable (Burrows, 1998, p. 31).

World War II

World War II spurred tremendous development of advance aeronautical research, design, and production. It forced the primacy of military aeronautical research and development that was incorporated into civilian applications secondarily. Rocketry was still the province of well-organized amateur entities like the American Interplanetary Society, the American Rocket Society, the British Interplanetary Society, and the Verein fur Raumschiffahrt (Society for Space Travel, or VfR), to which belonged a bright young engineer named Werner von Braun (Burrows, 1998, p. 65). However, the military soon recognized the potential for rocketry, in particular the German military through research, development, and production of the V-2 liquid-propellant ballistic missile at Peenemuende. Military involvement in Rocketry was critical, since advancing the technology became so expensive so quickly that only national treasuries could afford to do so and thus paved the way for the professionalization of Rocketry and its support infrastructure (Burrows, 1998, p. 64). Rocketry thus also fell into the same pattern as aeronautics did in NACA, in that both military and civilian applications were forever intertwined and inseparable. Criticism of NACA emerged during WWII when critics pointed out that the United States lagged behind Great Britain and Germany in terms of jet propulsion research, development, and production (Bilstein, 1989, p. 31). These types of criticism would be an important and continuing factor in the search for a coherent organizational entity that could meet the challenge of the new space age.

Beginnings of the Cold War

Following WWII, there was a conscious decision by von Braun and some of the best German engineers and scientists at Peenemunde that "We despise the French; we are mortally afraid of the Soviets; we do not believe the British can afford us, so that leaves the Americans" (Burrows, 1998, p. 108). The use of the ballistic V-2 rocket had convinced both the United States and the Soviet Union that the men and materials in

Germany were critical and needed to be captured, with both countries jockeying for position to try to capture as many of the records and people for the impressively capable V-2 as they possibly could. The United States, through superior intelligence work and successful covert activity, brought more than 360 metric tons of V-2 materials out of the designated Soviet zone and approximately 350 Germans to the United States, to include von Braun, whom the Russians had tried to kidnap (Burrows, 1998, pp. 114-120). The Soviets also captured several Germans experts that eventually led their V-2 efforts. The Army then put von Braun and his team to work at White Sands Missile Range on the captured V-2s, and subsequently transferred them to Redstone Arsenal, Huntsville, Alabama, where they formed the core of the Army Ballistic Missile Agency (ABMA), developing the Corporal, Sergeant, and Redstone battlefield missiles in coordination with the Jet Propulsion Laboratory in Pasadena, California (Bilstein, 1989, p. 43).

Interservice rivalry intensified with the Army efforts in Rocketry following WWII. Both the Navy and the Air Force jockeyed for position in intense political maneuvering in order to secure funding. For the Navy, this would result in the successful Viking high-altitude research rockets and in its successful partnership of the Naval Research Laboratory in the Army V-2 program to allow civilian experiment packages to hitchhike on military rockets, one result of which was the discovery of the Van Allen Radiation Belt surrounding the Earth (Burrows, 1998, pp. 129-134). Despite the interservice rivalry, this partnership of civilian scientists and defense would play an important and continuing role in the development and events of the United States Space Program up to the present day. This is undoubtedly part of what Eisenhower would warn against when he was President, referring to the "military-industrial complex" and its voracious appetite for government dollars.

The testing of the first Soviet atomic bomb in 1949 and the first Soviet hydrogen bomb in 1953 fueled military investment in missiles at a tremendous pace, leading to the development of the Nike anti-aircraft family and nuclear-capable offensive weapons across the services, such as the Air Force's Atlas, Thor and Titan, the Army's Jupiter, and the Navy's Polaris. The Soviets were now an extremely dangerous adversary, and the military build-up was in full swing. Civil defense preparedness activities included images of teachers running nuclear attack drills in schools, with children huddling under their desks as warning sirens wailed throughout small towns across America. The FBI was investigating suspected communists throughout every level of society. The government and Senator Joseph McCarthy conducted investigations in order to root out suspected communist moles within the government. In spite of this, a coherent national space policy was still nowhere in sight, and the competition between the services continued. President Truman's response to a preliminary plan to send an American satellite into orbit for the International Geophysical Year (IGY) of 1957-1958 was indicative of the government stance: he called it "hooey" (Burrows, 1998, p. 139).

Despite this, aggressive lobbying by prominent scientists and engineers kept the idea alive.

Von Braun, for his part, was not taking things easy. He and his disciples created a popular presentation (consisting of detailed descriptions, cutaway drawings of a space station, a three-stage shuttle booster combination, an orbiting telescope and observatory, space taxis, satellites, space suits, manned maneuvering units, emergency capsules, and a detailed plan for expeditions to the Moon and Mars) published in *Collier's* magazine that ran in eight issues from March, 1952 to April, 1954, collectively titled *"Man Will Conquer Space Soon"* (Burrows, 1998, pp. 142-146). This magazine article became the unofficial plan by which the Americans would move forward in the space effort. Meanwhile, the IGY proposal was won by the Navy's Vanguard project against the Army and von Braun. One suspected reason for this decision was a lingering, visceral hostility toward the Peenemunde elite, a feeling that Redstone and Jupiter rockets possessed Nazi bloodlines, and that Vanguard was made in America (Burrows, 1998, p. 171). In the Soviet Union, the Russians successfully tested a booster called the R-7 in 1957, and announced in the Moscow Evening Paper that they were also intending to launch a research spacecraft in conjunction with the IGY, with Khrushchev approving the Sputnik space missions in order to boost his shaky party standing and back up his rhetoric of Intercontinental Ballistic Missiles (ICBMs) rolling off Soviet assembly lines like "sausages" (Burrows, 1998, p. 177).

The Soviet Challenge

A faulty intelligence report had mistakenly told one of the Chief Soviet Designers, Sergei Korolyev, that the United States was planning to launch a satellite in late September or early October of 1957, so he decided to go with the simplest Sputnik configuration out of the three that were available for consideration (Burrows, 1998, p. 185). On October 4, 1957, the Soviets became the first nation to successfully launch a manufactured satellite into orbit around the Earth. The Sputnik weighed 183 pounds, as compared to America's Vanguard and its intended start at 3 pounds, working up to 22 pounds in later satellites (Bilstein, 1989, p. 44). As underestimated in the early Rand report, panic was spreading in the United States. Everyone in Washington had assumed that the United States, with vastly superior technical and industrial capability, would be first, and it came as quite a shock that they weren't (Logsdon, 1992). One month later, the Soviets launched Sputnik II, weighing 1100 pounds, carrying a live passenger in the form of a mixed-breed terrier named Laika, proving to the world that the first launch was not a hoax or a fluke. It also showed that the Soviets indeed possessed ICBM capability, possessed an unprecedented physical sciences platform, and it signaled their intentions of putting man into space (Burrows, 1998, pp. 197-199).

President Eisenhower was now under extreme pressure to catch up immediately. He authorized von Braun to move ahead and announced the American launch response of the Vanguard for December of that year. Following the launch of Sputnik I, there was a clear effort by many in the Eisenhower administration to downplay the Soviet achievement, as summarized by James Hagerty, the White House Press Secretary, saying "We never thought of our program as one which was a race with the Soviets…the satellite launching did not come as any surprise to the U.S." (Logsdon, 1992). The Vanguard rose 3 feet off the launch platform, shuddered, and collapsed in flames, with its tiny 3 pound payload rolling away from the inferno, beeping impotently (Burrows, 1989, p. 47). This added to the building pressure and panic, with several politicians advancing to the forefront. One of them, Lyndon Baines Johnson, would play an important role in the future of the American Space Program. Johnson held hearings on the Preparedness Subcommittee in the wake of the Sputnik I and II launches and grabbed the headlines and TV coverage as he had planned, casting himself as "Mr. Space" (Logsdon, 1992). Finally, the United States successfully launched the von Braun ABMA-JPL Explorer in January 1958, alleviating some of the pressure that was building in Washington.

NASA is Born

The development of a coherent National space policy had come to the forefront because of continued Soviet achievements in space. As early as the summer of 1957, the US IGY Satellite Committee had thought about a National space establishment (Burrows, 1998, p. 213). There was intense political rivalry in the form of the military services, the Atomic energy Commission, and NACA, but Eisenhower and Congress were united in their desire to avoid projecting Cold War tensions into the space arena (Bilstein, 1989, p. 47). Burrows (1998) credits James Killian, Eisenhower's Special Assistant for Science and Technology, for providing strong direction in answering the critical questions: what would the new establishment accomplish, would it be civilian or military, and would the new establishment be grafted onto an existing organization or created from scratch? NACA was a prime candidate, but many felt that it had withered into a timid bureaucracy, afraid of making enemies in order to protect its research interests and funding, as well as possessing too many ties to the military (Burrows, 1998, p. 218). Following much political jockeying, a compromise was formed with the creation of a redesigned NACA through the Space Act of 1958, the National Aeronautics and Space Administration (NASA). The only thing reserved from NASA was the military imperatives that found their natural home with the Department of Defense. The Soviets had succeeded in waking up a sleeping giant that possessed immense resources in technology and brainpower.

From the beginning, NASA was a political minefield, surrounded by competing interests and possessing little immediate and obvious impact on the day-to-day existence of regular people, problems that currently bedevil the Agency. The first NASA Administrator, T. Keith Glennan, had to deal with the fundamental problems of any research and development organization: the balance between administration and innovation, the justification and balance between pure research and applied results, and the tensions created by brilliant people with competing individual and organizational loyalties. The seeds that were planted by the creation of NASA continue to this very day in the form of rivalries between industry, academia, and the government; between proponents of manned versus unmanned exploration; and between the various Centers of NASA, each with its own particular culture and political expediencies. The Centers were created and acquired by Glennan right from the start for survival, just as military bases were spread across as many voting districts as possible. NACA contributed the Langley Research Center in Virginia, the Ames Research Center in California, and the Lewis Research Center in Ohio, as well as the High Speed Flight Station at Edwards Air Force Base in California and the Wallops Flight Facility in Virginia. Glennan, after vicious political maneuvering, succeeded in wresting the ABMA and JPL from the Army (Burrows, 1998, pp. 259-261). JPL remains to this day as it did then, under CalTech, working for NASA as a contractor. The Goddard Space Flight Center in Maryland followed in 1959, the Marshall Space Flight Center in Alabama in 1960, and the Johnson Manned Spacecraft Center in Texas in 1961, reflecting the political power of LBJ who was committed to space exploration and played an important role in the creation of NASA.

The Race to Space

Eisenhower approved Project Mercury, but vetoed the moon mission in 1958. Preparations for Project Mercury had in reality begun much earlier, but were ready to go once NASA was created from the NACA infrastructure. The scientists and engineers now waited for a more sympathetic President to come to power, an institutional pattern that would repeat itself over the years up to this present day. NASA named the Mercury 7 astronauts in May 1959, and the race was unofficially on to the moon. In the Soviet Union, Korolyov was doing everything possible to keep the spectaculars coming in order to obtain continued funding for the corrupt, militarized, inefficient Soviet space program (Burrows, 1998, pp. 275-277).

NASA relied on the military infrastructure for much of its early space flight efforts (research airplanes, boosters, administrative support, the Army Corps of Engineers, communications satellites, procurement systems, and, most importantly, astronauts). NASA also began to grapple with the issues involving research and development, and how this important activity would occur within the complex relationships of the public and private sector. The definition of NASA's relationship to private industry continues to create problems up to the present day.

President Kennedy was elected as president in 1960, and was initially against the space program, considering it too expensive (Bilstein, 1989, p. 57). Then the Russians launched Cosmonaut Yuri Gregarian into space for one orbit in April 1961, and the new administration was put on the defensive. Alan Shepard rode the Freedom 7 Mercury spacecraft into a considerably shorter suborbital flight in May 1961, but the world perception that the Russians were considerably ahead in the space race was reinforced. This watershed event placed Vice President Lyndon Johnson back into the limelight as a key space program supporter. James Webb, the new NASA Administrator, and Robert McNamara, Secretary of Defense, joined forces to apply the government-industry-university team towards achieving a manned lunar landing and return mission as a primary objective in a broad-based program of boosters, communications satellites, meteorological satellites, and planetary exploration (Bilstein, 1989, 57). President Kennedy handed NASA a blank check in announcing the goal before a joint session of Congress on May 25, 1961 (Bilstein, 1989, p. 57):

> "Now is the time to take longer strides---time for a great new American enterprise---time for this nation to take a clearly leading role in space achievement, which in many ways may hold the key to our future on earth……I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth. No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish."

The die was cast in terms of how NASA would need to organizationally handle the effort. All Centers would need to contribute, but strong control from NASA Headquarters was essential in coordinating the massive public and private sector enterprise, a massive centralized hierarchical bureaucracy riding herd over strong individuals and competing interests, balancing against political expediency and different organizational cultures. The difference was that these competing interests were focused on a single national goal, and the effort was supported with essentially an unlimited budget. Levine (1982) commented on the hierarchy that was developed in order to get to the moon:

> "To understand what NASA did, one must begin by considering it as an institution coordinated to achieve certain goals that were neither fixed nor always precisely determined. Coordination had to be achieved on different levels: within the Agency among the substantive program offices, the several field installations, and the central functional offices; between NASA and the Executive Office of the President, which determined the funding levels of each item in the NASA budget before Congressional review; between NASA and the Congressional committees that authorized its programs, allocated its funds, and provided continuous oversight; between NASA and the scientific community , which was client, critic, and not-so-loyal opposition; finally between NASA and other Federal agencies, which might be partners, rivals, or symbiotic."

Additionally, NASA provided oversight to the thousands of contractors and subcontractors who were responsible for critical elements of every program that the Agency executed. In the early 1960's, the infrastructure emerged to support lunar-orbit rendezvous, an initially risky scenario that finally emerged from the politically charged NASA environment as the method of choice in going to the Moon. Project Mercury quickly resulted in John Glenn becoming the first American to orbit the Earth in 1962, and continued until 1963, making the Mercury 7 Astronauts national heroes in the process. Concurrently, there were additional successes and advances in communications satellites and weather satellites, as well as the *Mariner 2* fly-by of Venus. The Ranger program, after six initial failures and the near elimination of JPL as a result, underwent reorganization under pressure from Congress and resulted in *Ranger 7* sending back the first close-in pictures of the Moon prior to its impact on the surface.

NASA Administrator Webb also initiated programs to answer charges that Project Apollo would drain the nation's scientific manpower, as well as not serve the broader needs of the nation's economy. By the end of the program in 1970, NASA footed the bill for graduate education of 5000 scientists and engineers at a cost of over $100 million, had spent $32 million for the construction of new laboratory facilities on 32 university campuses, and given multidisciplinary grants totaling over $50 million to approximately 50 universities, as well as awarding over $100 million in NASA contracts and grants for research (Bilstein, 1989, pp. 64-65). Webb also created the NASA technology utilization program, resulting in 30,000 uses of space technology for use by the civilian economy by 1973, with 2000 additional new uses annually (Bilstein, 1989, p. 65). The technology program also resulted in 2000 companies receiving direct NASA technology assistance and answered 57,000 additional industry queries, resulting in new products like quieter aircraft engines, microelectronics, and manufacturing testing software (Bilstein, 1989, p. 65). However, Webb also realized that the science community had to be on board for the long-term effort. It was a telling comment by Professor David J. Helfand, Department Chair of Columbia University's Department of Astronomy, that put the whole manned effort into context, and who pinpointed a characteristic of NASA that persists to this very day (Burrows, 1998, p. 336):

> "A convincing argument can be made that one would not get any money for space exploration without men in the loop; that the public funds space science because of the emotional issues involved with putting men in space. The next thing has to be much more spectacular than the last thing or it's not worth doing, because they're not fundamentally interested in doing the science; they're fundamentally interested in the technological achievement. The Agency is driven, from top to bottom, as far as I can see, by creating reasons for itself to exist."

This sentiment is still shared by many individuals today in the space science community and by some in the American public. The Agency's adversaries point to the fact that the manned International Space Station and the Shuttle remain the most expensive and heavily funded items in the NASA budget annually, and continue to roll up the largest cost overruns of all programs.

NASA created Project Gemini in 1962 to fill the technological and experience gaps for realization of Project Apollo. Project Gemini resulted in a multitude of experiments and immeasurable operational experience, and again displayed the synergy between the military and NASA through the continued use of military test pilots and the Titan 2 Intercontinental Ballistic Missile as the booster. It also marked the beginning of the end of the space race, for with Gemini, the United States pulled ahead of the Soviets and their inefficient and corrupt governmental structure. By this time, Khrushchev had been removed from power, and Sergei Korolyov had died prematurely, leaving the Soviet program rudderless.

The NASA budget advanced from $966.7 million in 1961 to $1.825 billion in 1962 to $3.674 billion in 1963 to $5.1 billion in 1964, and personnel numbers grew from 17,471 to 35,860, with more than 400,000 contractors working on the program at the peak of Apollo. Politically, there were inevitable questions on the massive expenditures, but the Soviets were still ahead, orbiting 2-man then 3-man spacecraft, flying tandem missions, orbiting an unmanned prototype spacecraft, taking the first photographs from space, achieving the first long-term space missions, conducting the first formation flights in Earth orbit, successfully launching the first woman into space, achieving the first manned space walk, sending the first spacecraft into lunar orbit, and achieving the first soft-landing of a spacecraft on the lunar surface. These Soviet achievements continued to fuel the American program, and kept the critics of the space program at bay. Regardless, President Johnson asked Webb in 1964 to begin planning for a post-Apollo NASA. As a result, Webb now geared towards Project Apollo in order to achieve the goal of landing a man on the Moon, requiring that other NASA basic research and applied research efforts align themselves to support of the massive effort and also share the pain of budget cuts, downscoping requirements, and cancellation if necessary. NASA was pursuing a broad range of other activities that included significant advances in weather and communications satellites, but these programs were in the shadow of Apollo, which captured the lion's share of the budget as well as public attention (Sisung, 1999).

Project Apollo concentrated on advancing booster capability, beginning with the *Saturn I*, evolving to the *Saturn IB*, and graduating to the *Saturn V*. Coordination began to take shape in integrating the huge technological puzzle of making sure that the booster and its stages, the command and service module, and Lunar Lander all worked together. The number of narrow escapes that occurred during the Mercury and Gemini years was never reported to the public, and perhaps it was inevitable that the odds would finally catch up with NASA. In 1967, Astronauts Virgil Grissom, Edward White, and Roger Chaffee died in a flash fire in a pure oxygen environment during preflight tests aboard the vehicle for the planned first manned Apollo mission. The congressional investigations that followed the first American space program deaths in history proved to be the beginning of the end for Webb's support on Capitol Hill, and delayed the Apollo program for 18 months at a cost of an additional $50 million (Bilstein, 1989, pp. 80-81). Webb resigned in 1968 as NASA Administrator due to Richard Nixon's election as President, and Thomas Paine took the reins. The odds publicly caught up with the Soviets three months after the American disaster when Colonel Vladimir Komarov died, hitting the ground under tangled parachutes at 400 miles per hour (Burrows, 1998, p. 413). The American and Soviet programs were paying significant costs for moving at a speed that their organizations could not maintain.

The *Apollo* program, after months of agonizing delay and unmanned testing of the components of the booster, the command module and the lunar module, finally became a manned mission with *Apollo 7* in 1968, validating all of the critical subsystems in an 11 day Earth orbital flight. With the end of the decade looming, NASA's George Low submitted a bold proposal that was accepted by NASA senior management due to the success of *Apollo 7*: *Apollo 8* was a lunar orbital flight, and for the first time, human beings went into orbit around another body instead of the Earth. NASA at this point was feeling the heat of the Soviets and their last gasping efforts to reach the finish line before the Americans did. The huge gamble with *Apollo 8* paid off, setting the stage for *Apollo 9* and *10* to establish the trustworthiness of the lunar module. Meanwhile, the Soviets endured disaster after disaster of exploding rockets, software malfunctions, and lost opportunities. The years of political ambivalence, institutional fear and scorning of science, competition with the military, internecine treachery, a chronically hemorrhaging economy, wasted resources, obsessive secrecy, management debacles, and an unwieldy and often unresponsive support system had defeated the Soviets and their best and brightest (Burrows, 1998, p. 421). Apollo 11's lunar module landed on the moon with Astronauts Neil Armstrong and Edwin Aldrin on July 20, 1969, and ended the race to the Moon.

The Aftermath of Success

At the peak of humankind's greatest achievement, Vietnam was draining the United States of money and her sons and daughters, and societal upheaval was being broadcast into American living rooms every evening in concert with the latest body counts from the battlefields of Vietnam. Johnson's War on Poverty program was becoming increasingly expensive without providing tangible results. The public was losing faith in big government programs, and the last thing on the public's mind was the space program. The long knives emerged, and Congress cut the NASA budget to $3.7 billion for 1970, forcing NASA to delete three flights. New planetary exploration programs were cut, but previously approved programs such as Mariner, Pioneer, and the Orbiting Solar Observatories continued to successful completions. *Apollo 12* completed a successful mission, replicating a perfect lunar landing and ascent, but *Apollo 13* flirted with near disaster in 1970 when an on-board oxygen tank exploded on the way to the Moon, severely crippling the command module. The lunar module was used as a lifeboat, and returned the Astronauts safely back to the Earth. The following missions were all successful and resulted in a rich harvest of scientific data. *Apollo 17* was launched in 1972, and closed out the program after 11 ½ years, $23.5 billion, 12 men landed successfully on the Moon, and a mountain of scientific and technological data. It had also proven that the academic, government, and private industry communities could successfully unite behind a common goal and achieve incredible things. Despite the budget cuts and mission cancellations, space had proven itself to be in the national interest. Nixon's Space Task Force ensured that the manned program would continue somehow under the new budget realities through creation of a low-cost shuttle system, construction of a manned space station, and then a manned expedition to Mars, following the blueprint of the earlier von Braun's *Collier's* magazine feature. This kept the space scientists happy, piggybacking on the manned exploration plan, playing second fiddle as long as it allowed their programs to go forward. This would result in several astonishing successes through the Mariner-Mars missions and the Mariner-Venus missions, along with the hugely successful Viking mission to Mars that successfully deposited two landers that transmitted weather, biological, and seismic data from Mars while two orbiting platforms mapped the majority of the surface in 1976. Pioneer spacecraft explored Venus and Voyager spacecraft explored Jupiter and the outer planets through 1979. However, the shrinking budget would prove to be even worse than anyone could have predicted, and new space science missions fell by the wayside. There were notable exceptions, such as the various future Pioneer, Mariner and Voyager missions.

The next practical focus in the manned arena for NASA was Skylab, meant to be an orbiting laboratory for the conduct of several important scientific experiments. The Skylab project was designed to demonstrate that man was capable of extended stays in space while continuing to accomplish useful work, which it accomplished. With the tremendous budget cuts that were taking place following Apollo, project management within NASA became more hectic and risky, but the Agency persevered, completed all experiments, and retrieved valuable data on astronomical and Earth surveys. The additional advantage was the proof of concept for a viable space station that would allow for cooperation with the Soviets on a major mission, culminating in the Apollo-Soyuz mission in July 1975. Despite these successes, the 1970s were shaping up to be a difficult time for the Agency, which continued to suffer withdrawal symptoms from operations conducted under the Apollo way of doing business. By the end of the decade, NASA personnel would drop from a high of 37,000 in 1967 to 25,000 (Sisung, 1999).

Administrator Paine began seriously studying the concept of a space shuttle that would reduce the cost of missions through use of a reusable orbiter as outlined in the original report of the Nixon Space Task Force. Various configurations of the shuttle were proposed and designed over these years, but Administrator James Fletcher in 1971 quickly decided that the ultimate $10.5 billion development cost was too expensive, and redesigned the vehicle to employ assisted take-off through the use of reusable solid rockets and an external fuel tank, the present-day configuration of the shuttle. With the budget numbers much more to his liking, President Nixon, who had little use for the space program, approved the project in 1972. The Europeans, who committed to participation through the development of Spacelab for the cargo bay after significant political battles and negotiations, began significant international participation.

The shuttle, or Space Transportation System (STS) would quickly become the largest consumer of the NASA budget and management attention (Bilstein, 1989, p. 110). Unlike the Apollo program, the shuttle was conceived, designed, and built as a series of compromises in order to win political approval year after year, and it showed through engineering rework and budget overruns through 1980. Congress told NASA that the Cadillac version was out, and even the Chevy version would have to be fully justified (Burrows, 1998, pp. 518-519). The design of the STS ended up being more complicated, requiring a tremendous logistics effort to keep the launch schedule intact. It also made the launches more difficult and risky, to include having to launch in cold weather in order to stay on schedule, and the STS would have to be the only way to get people and payloads into space in order for it to be cost effective, requiring that military launch systems would have to be scrapped (Burrows, 1998, p. 520). The STS was a political football that embarrassed the Agency, and made it a high profile target for the Office of Management and Budget and the Air Force, who did not want to be dependant on a civilian transportation system. President Carter, who was embarrassed by the inability of the United States to launch satellites for Salt II arms control verification purposes due to shuttle delays, finally ordered that the STS be built regardless of the cost, which finally soared to $10 billion (Burrows, 1998, p. 523). STS *Columbia* finally launched on its maiden voyage in April 1981 after years of frustrating delay, using an engine untested in flight and the more dangerous solid rocket boosters that could not be aborted once they were lit. In spite of the potential for disaster, Columbia performed as advertised, and the age of the shuttle began.

NASA issued the first 5-year launch plan for the shuttle in 1980, scheduling 37 flights through 1985, and predicting 500 flights by 1991 (Burrows, 1998, p. 525). The political costs of staying on schedule and succeeding with the STS were adding up quickly, and no one pulled the Agency out of its self-made tailspin. STS *Discovery* and *Challenger* were delivered in 1984 and *Atlantis* in 1985, with the use of all shuttles leading to the successful performance of 24 missions over a period of 5 years, at a cost of approximately $500 million per shuttle flight (Burrows, 1998, p. 552). The public would get used to space travel on the STS as an everyday occurrence, devoid of danger or complications, who did not realize that there were hundreds of potential malfunctions that could result in a catastrophic loss of the system and its crew. The political implications of falling further behind in the launch schedule resulted in a dangerous environment where a catastrophic failure was perhaps inevitable. Added to this was the public relations campaign to conceal the engineering and logistical problems, to include the increasing diversity of the crew for the STS missions (women, representatives from international partners such as the European Space Agency, and politicians). In 1984, President Reagan announced the first citizen passenger on the STS, a woman schoolteacher from New Hampshire named Christa McAuliffe. Plans were also developing to send the first journalist into space, with Walter Cronkite as one of the candidates, a friend and fan of the Agency who was overcome by emotion on national television during America's triumph of landing on the Moon. In 1984, President Reagan also endorsed Space Station Freedom, destined to follow the same tortured incremental development path of the STS. It underwent several revisions, with budget priorities dictating the baseline configuration of the Space Station to its present day incarnation, the International Space Station. Thus von Braun's original *Collier's* blueprint was still moving forward, though in fits and starts.

On January 28, 1986, STS *Challenger* lifted off at Kennedy Space Center on a frozen Florida morning, manned by a diverse crew that represented America in many dimensions. Complacency about the dependability of the shuttle and the routineness of space travel were shattered forever when the Challenger exploded 73 seconds into liftoff in a cold clear sky, in front of the whole world, in front of the families and friends of the astronauts, in front of the horrified managers who had willingly and unwillingly allowed or forced the launch, and in front of the public affairs personnel who had spun an artificial world of space travel devoid of risk. The still-intact crew compartment climbed to 65,000 feet and then plummeted into the ocean at a speed of 207 miles per hour; a NASA report conceded the possibility that the crew may very well have been conscious through the explosion, desperately surviving all the way down to impact on the ocean (Burrows, 1998, p. 556). NASA immediately reacted by circling the wagons, restricting information access, impounding records and tapes, and carefully screening public pronouncements (Burrows, 1998, p. 557).

The Rogers Commission, headed by former Secretary of State William Rogers and appointed by President Reagan, pinpointed the engineering fault as a faulty solid rocket booster O-ring in the right solid rocket booster that was hardened by the cold weather and overcome by the tremendous dynamics of the burning booster. The investigation discovered that NASA and Thiokol, the supplier of the booster, were aware of the issue for months before the launch. The Commission blasted NASA management and called for major overhauls in shuttle design and operations. The report also noted that over the years NASA had drifted in its mission focus from a primarily research and development orientation and had evolved into an agency that indulged in showy and expensive operations (Sisung, 1999). The political pressure from the Administration and Congress to maintain 24 shuttle launches a year in order to justify the program had claimed the lives of seven astronauts (Burrows, 1998, p. 558). When the other political justifications of the scheduled lesson plan for McAuliffe (which needed to be delivered on a weekday for maximum public relations value) and President Reagan's State of the Union address (which needed to mention the mission and McAuliffe that evening) were added to the launch equation, the inevitability of the launch decision was set, driven by public relations concerns and not by safety and solid engineering (Burrows, 1998, p. 559). NASA had come to believe its own propaganda, institutionalized since the days of Apollo, that technology and engineering would always triumph over random disaster if certain rules were followed, where equations, geometry, and repetition through physical law, precision design, and testing must defy chaos (Burrows, 1998, p. 560). Arrogance and conceit persuaded the managers of the manned program that 6 trips to the moon and 24 shuttle flights without a deadly accident proved that technology would always triumph over fate; that their numbers were better than God's (Burrows, 1998, p. 560). Since the shuttle was the only option, flights were delayed for over a year and a half. Military and civilian payloads waited in line, including the Hubble Space Telescope. James Fletcher returned as NASA Administrator, during which time NASA was besieged by a further missteps and mistakes, including the inability to send a mission to Halley's Comet, and a string of launch failures involving weather, communications, research, and military payloads. The Agency was in deep trouble.

As with every cliché, there is some basis of truth to the notion that every cloud contains a silver lining. Because of the *Challenger* disaster, the American public was reawakened to the issues of space. Several studies reported significant increases in the favorability ratings of space-based projects such as the shuttle and the space station, and that funding should stay at the same level or increased for NASA (Burrows, 1998, p. 561). NASA returned to space in September 1988, with a flawless mission on *Discovery*. Speculation about the possible dissolution of the Agency went away, and NASA now focused on its two biggest priorities as it entered the 1990s: a manned mission to Mars and a space station.

The space station developed an inexorable inertia of its own within an Agency whose central canon called for mega-projects that, once under way, would be difficult to cancel (Burrows, 1998, p. 592). It climbed in cost year after year, survived numerous attempts at killing the program in the cradle (squeaking through one Congressional attempt by 1 vote), underwent significant personnel changes, and suffered repeated crises of purpose. Since the cold war was over, it was designated the International Space Station in 1994 and involved international partners, including the Russians, in sharing costs. This would prove to be a very expensive gamble that was driven by political considerations more than engineering requirements. As with the STS, mounting cost and schedule overruns were driving potential benefits of the project beyond 2000, and NASA was pulling money away from space science in order to keep the manned program alive and viable. Matching the space station in terms of a tortured birth was the Hubble Telescope, which survived numerous political turf battles, academic arrogance, funding cliffhangers, and restricted operational capabilities due to constraints imposed by the STS, only to be launched and deployed with a flawed mirror that made it useless. NASA redeemed itself in 1993 with a spectacular rescue mission that made the Hubble into a modern-day miracle of scientific research, revolutionizing how we viewed ourselves and the universe, restoring much of the Agency's damaged credibility with one mission.

Regardless of the successful return to space of the STS and its unblemished safety record since the *Challenger* disaster, NASA was widely seen as an agency without a coherent mission at the beginnings of the 1990s (Burrough, 1998, p. 239). Since *Challenger*, the Agency had struggled with the very same problem that had plagued it at birth: the United States could move forward without skipping a beat if NASA disappeared tomorrow. President Bush earlier had formed the National Space Council in 1989 and put Vice President Dan Quayle in charge of refocusing NASA. Quayle turned to Mark Albrecht to run the staff and to create a mission for the Agency. In 1989, President Bush announced that the United States would put a man on Mars within thirty years, but there were no details to this plan, and NASA failed to deliver alternatives that were palatable in terms of budget for the Administration (Burrough, 1998, p. 240). As a result, NASA Administrator Richard Truly alienated himself from the Bush Administration. When the Deputy Administrator job opened in 1991, the candidates made it clear that they would not take the job as long as Truly remained NASA Administrator, and former NASA Administrators James Beggs, Thomas Paine, and James Fletcher advised Quayle that Truly has to go (Burrough, 1998, p. 241). Albrecht put together a short list of candidates with one unknown quantity named Dan Goldin, a TRW middle manager with a penchant for telling people that NASA was too "stale, pale, and male" and that the Agency needed to do things "faster, cheaper, better" (Burrough, 1998, p. 244). The Senate confirmed Dan Goldin as the ninth NASA Administrator in record time in March 1992. He was viewed by the Agency as an outsider, and NASA prepared to resist in every way the changes that were being mandated by the White House. However, the new Administrator knew something that NASA management did not. They had no choice.

Goldin proceeded to revolutionize the way business was conducted at NASA under very difficult circumstances. Big Science is hard to do in an environment of downsizing and budgetary cutbacks, and Goldin realized that NASA could not move into the future with the Apollo era hierarchy and management practices that were still in place. He also felt that the big-ticket items would continue to sap the strength of the Agency in moving to new programs and projects unless he forced them to implement a new management approach. He understood that he would have to let blood, or have it done for him (Burrows, 1998, p. 616). Under his stewardship, the Agency initiated management reforms that resulted in a budget drop from $14.3 billion to $11.7 billion, dropped from 21,000 personnel to 17,500, cut contractor personnel, and initiated the handing over of shuttle operations to private industry. The Agency moved forward with the successful initiation of construction for the space station, continued safe and productive STS missions, launched major new space observatories to complement the Hubble, and launched significant space science missions such as the Cassini mission to Saturn. The public relations successes continued also, such as Senator John Glenn returning to space on a second mission as the oldest astronaut to ever fly into space.

"Faster, Better, Cheaper"

To achieve the mandate that he had received from the White House, Dan Goldin initiated a management approach that he called "Faster, Better, Cheaper (FBC). He felt that the FBC approach would transform the cumbersome Agency into an excellent research and development organization.

The FBC approach achieved a spectacular scientific and public relations success with the launch of the $185 million Mars Pathfinder mission in 1996. The Pathfinder landed on Mars on July 4, 1997, and instantly captured worldwide attention and through its successful lander and rover operations on the surface of the Red Planet. More importantly in the view of NASA, the mission was a very public success of the FBC approach. The team identified several important elements of their success: the team and its desire to succeed; the visible, hands-on leadership of the managers; the ability of the team to set its own ground rules within the traditionalist structure of the larger organization; setting stretch tasks for team members in order for them to grow and develop; an atmosphere of trust and integrity; having team members work in the same building; and setting hard and fast rules on development and testing, not short-changing either element (Muirhead, 1999). Its companion mission that was launched in 1996, the $154 million Mars Global Surveyor, followed some of the same principles of FBC management and discovered evidence of the possible existence of water on Mars, and has been successfully mapping the surface of the Red Planet.

Pathfinder was followed by another FBC mission, Deep Space 1, which NASA successfully launched in 1998. The mission successfully demonstrated a number of advanced technologies, to include ion propulsion and an artificial intelligence onboard navigation system. The FBC approach again achieved a significant win with the success of this project. The mission pushed the use of new technologies at a fraction of the cost of traditional Big Science programs.

The pitfalls of a FBC approach have been vividly demonstrated through the recent high profile failures of missions that were specifically identified as employing the FBC philosophy. In August 1997, the $71 million Earth-observing spacecraft Lewis fell from orbit after launch. The failure board pinpointed that the contractor TRW did not properly test the attitude control system. As a result, NASA cancelled the companion mission Clark due to cost and schedule overruns, sacrificing $55 million.

On December 11, 1998, NASA successfully launched the Mars Climate Orbiter from Cape Canaveral on a mission to study the Martian atmosphere, part of a set of two missions that would complement each other in delivering useful scientific data towards the goal of returning a Martian planetary sample back to Earth. The other mission was the Mars Polar Lander, designed to actually land on the surface and analyze Martian soil samples. The Jet Propulsion Laboratory (JPL) controlled the design, spacecraft development, payloads, and the launch of the systems. In September 1999, NASA lost the Mars Climate Orbiter mission when it entered the Martian atmosphere at a lower than expected trajectory. A root cause analysis pinpointed a failure to convert English units to metric units for a key spacecraft operation resulted in the loss of the spacecraft (NASA Mars Climate Orbiter Mishap Investigation Board Phase 1 Report, 1999).

In January 1999, NASA launched the Mars Polar Lander and two Deep Space 2 microprobes on a mission to land near the edge of the Southern polar cap. It was equipped with a robotic digging arm and two microprobes designed to crash into the surface of Mars and conduct soil and water experiments. In December 1999, JPL lost contact with the lander as it attempted to land on Mars. Contact with the microprobes was never established, and there was no telemetry data available to analyze any stage of the entry, descent, or landing phases of the mission. NASA engineers determined probable failure causes to be premature engine shutdown due to a sensor that was not tested properly before launch signaling an early touchdown, causing the descent engines to stop prematurely, and inadequate software design and systems testing for the Mars Polar Lander (NASA Report on Loss of Mars Polar Lander and Deep Space 2 Missions, 2000), including the Deep Space 2 Microprobes, where it was deemed as not adequately tested prior to launch and were thus not ready for launch. According to NASA, the combined cost for the two failed Mars missions was $365 million.

There have been other FBC-related failures. A September 1999 IG audit questioned the "cost reasonableness" of the X-33, the $1.2 billion NASA-subsidized prototype of Lockheed Martin's proposed VentureStar reusable launch vehicle, widely seen as the space shuttle replacement. In 1999, the X-33's advance composite fuel tank failed a key qualification test (NASA X-33 Fuel Tank Investigation Board Report, 2000). In another FBC project, uncertainties about flight test requirements have grounded the $186 million X-34 reusable launch vehicle technology demonstrator. Rapid prototyping of a $950 million, seven-passenger space station lifeboat X-38 is on target, but the $125 million craft, being developed and tested by a small band of NASA engineers, "warrants more risk management than current NASA policy requires," the NASA IG found in February 2000. These reports leave open how NASA will move into the future, and whether the Government Reinvention effort will simply disappear upon the selection of future new management teams.

APPENDIX B: CODE BOOK

Table 2: Code Book

Code Word	Parent	Text	Level	Definition
Better	More/Less	Yes	2	Management activities directed towards improving products and services over previous attempts in terms of schedule, cost, quality, technical performance, customer satisfaction.
Bureaucrat	Organization/ Management	Yes	2	Organizational elements in a clearly defined hierarchical structure containing specific roles, responsibilities, and expectations.
Buy-in	Workforce	Yes	2	Agreement, enthusiasm, and support, observable and otherwise, from individuals and organizational elements towards defined organizational strategy, including vision, mission, strategy, objectives, and tasks.
Communicate	Workforce	Yes	2	Oral, written, and nonverbal activities occurring at individual level through organizational team level that convey organizational issues in terms of vision, mission, strategy, objectives, and tasks.
Capability	Workforce	Yes	2	Activities at an individual and team level that convey a sense of competence and alignment with organizational preferences.
Cheaper	More/Less	Yes	2	Activities that lead to less expensive alternatives when compared with previous instances of similar activities.

Code Word	Parent	Text	Level	Definition
Compete	More/Less	Yes	2	The idea that faster, better, cheaper alternatives to previous activities results from allowing several organizations to struggle with each other towards ultimately developing a preferred approach.
Cost	More/Less	Yes	2	All alternatives are compared to an expense criterion for selection.
Culture	Organization/ Management	Yes	2	The value system of an organization that specifies desirable activities for attaining terminal organizational objectives.
Customer	More/Less	Yes	2	The idea that customer focus and requirements definition dictate the most effective and efficient activities for an organization.
Emotion	Workforce	Yes	2	Recognition and regulation activities concerning internal feelings and the feelings of other people.
Faster	More/Less	Yes	2	Achievement of results in less time as compared to past similar organizational efforts.
Flatter	Organization/ Management	Yes	2	Reduction of organizational layers and associated roles, responsibilities, policies, culture, expectations, and personnel.
Interact	More/Less	Yes	2	The concept that faster, better, cheaperapproaches interact to find an optimal balance in terms of effectiveness and efficiency.

Code Word	Parent	Text	Level	Definition
Method	Workforce	Yes	2	Activities that exhibit characteristics of particular leadership/management schools of thought and address their associated value system.
Metric	Workforce	Yes	2	A defined organizational standard that activities are measured against to determine success.
Mission	More/Less	Yes	2	The concept that organizational activities are tied to defined statements describing desired end states.
More/Less	None	Yes	1	A management philosophy affecting the organization that guides activities according to defined parameters in terms of relationships between the desired outcomes of faster, better, cheaper.
More Work	Organization/ Management	Yes	2	The condition of adding more work activities to a remaining fixed pool of employees to compensate for flatter organizational structures.
Motivation	Workforce	Yes	2	Activities designed to increase the level of effort by individuals and organizational elements towards achieving defined and desired end states.
Organization/ Management	None	Yes	1	Observable patterns of organizational elements and management processes and interrelationships that allow the organization to achieve its vision, mission, goals, and objectives.

Code Word	Parent	Text	Level	Definition
Outsource	Workforce	Yes	2	The concept that external organizations with specified core competencies can achieve desired end states faster, better, and cheaper than internal organizational capabilities.
Political	More/Less	Yes	2	Activities that may or may not be aligned to organizational culture and are characterized by compromise and conflict reduction.
Results	Workforce	Yes	2	Orientation towards comparing outputs and outcomes to clearly defined standards as revealed by associated metrics.
Rewards	Workforce	Yes	2	Activities that reinforce desired individual and team behavior.
Risk	More/Less	Yes	2	Activities that balance desired end states in schedule, cost, technical performance, quality, and customer satisfaction against constraints imposed by project type and resources.
Similar	More/Less	Yes	2	Activities that focus on lessons learned from past accomplishments as applied to present challenges.
Systems View	Workforce	Yes	2	Activities that recognize and leverage the pattern and interrelationships between all organizational elements.
Technology	Organization/ Management	Yes	2	Systems that connect discrete organizational elements into a pattern and enable interrelationships to form.

Code Word	Parent	Text	Level	Definition
Trust	Workforce	Yes	2	Commitment to individuals and teams by other individuals and teams regardless of organizational environment.
Workforce	None	Yes	1	Workforce capabilities that enable the organization to accomplish defined strategic elements (vision, mission, strategy, objectives, goals, tasks) under conditions of stability and change.

APPENDIX C: EXAMPLE CODED INTERVIEW

SAMPLE INTERVIEW

INTERVIEWER: Well, how long have you been in NASA?

SUBJECT: 11, 12 years.

INTERVIEWER: Twelve years; okay.

SUBJECT: Yeah; almost 12 years.

INTERVIEWER: Where did you come from? Straight from college?

SUBJECT: Yeah; from Penn State.

INTERVIEWER: Yeah; okay.

SUBJECT: Came down here and have been here--I've actually been here 13 years, but I was a student in here for the first couple years.

INTERVIEWER: Oh, great; okay. Internship program?

#-MOTIVATION
SUBJECT: Yeah. George Washington University has a program over in the Hangar Building, basically, where you take classes, and you get to work in a branch, and you get to work here at Langley on projects, and that's pretty much how I found [inaudible] I wanted to be a part of it, got hired, and two years later I got finished with my master's. It's been great. I mean, NASA's been real good to me.

INTERVIEWER: How did you end up getting your doctorate? When did you do that?

SUBJECT: In the fellowship program.

INTERVIEWER: Oh, great; okay.

SUBJECT: George Allison [ph] runs.

INTERVIEWER: Great.

SUBJECT: NASA sent me off to Stanford.

INTERVIEWER: Can't beat that.

#-MOTIVATION

SUBJECT: NASA's--in fact that was one of the reasons why I took the job, because I knew I wanted a Phd, and I knew I wanted to go to an expensive school. You know, NASA's got a great deal there. They–

INTERVIEWER: I set up the–

SUBJECT: I guess it's Ed's program.

INTERVIEWER: Yeah, the MIT program that they've got now, the accelerating leadership option.

SUBJECT: Oh, yeah. I know that one.

INTERVIEWER: We're sending folks up to MIT.

SUBJECT: Yeah.

INTERVIEWER: NASA's got--they seem to have a good policy towards--if it's worth--I mean, they'll develop their people by sending them to the best schools.

#-MOTIVATION

SUBJECT: Right. This was just a--this was a technical [inaudible] and this was a fellowship kind of thing where you go off to school and you--I went away for two years, and you owe three years for every year you're away, but you start paying back as soon as you come back.

INTERVIEWER: Yeah.

#-MOTIVATION
SUBJECT: I went to Stanford for a few years, took all the course work, started my research. Then I came back here and actually finished my research as part of my job–

INTERVIEWER: Oh, wow.

SUBJECT: It was great.

INTERVIEWER: Did your dissertation–

#-MOTIVATION
SUBJECT: My dissertation is what got me this job, really. My dissertation was in design, collaborative design and optimization theory.

INTERVIEWER: Great.

SUBJECT: Yeah. How to make good teams. How to get--how to distribute a design where you have people in different places around the country, all trying to work together.

SUBJECT: [inaudible] dissertation at Stanford, and then I kind a dropped it, completely, because I went and did Mars stuff for a while, and then when
#-CAPABILITY
they needed some help over here, they pulled me over here, and I think the

reason--I don't actually know for a |
$-SYSTEMVIEW
fact--but I think the reason that I |-$
got pulled over here was twofold. One | |
was because I had displayed some | |
systems engineering kind of knowledge, | |
and the second was that my | |
dissertation was in basically | |
collaborative design and optimization, |-$
which is a very ISE kind of topic. -#

INTERVIEWER: Yeah. Okay. So when you
first got into NASA, versus where it's
at right now, what are some of the
changes that you've seen and, you
know, just in your experience?

#-STRUCTURE
SUBJECT: Well, we're definitely -#
!-FLATTER
leaner and more streamlined. I would ! |
$-FLATTER
say that we're actually pushing the |-$
realm of feasibility in what--both in | |
what we're doing, and we're doing some | |
pretty exciting things--but also in | |
what we can do, because we've cut back | |
so much. I think back in, you know, |-$
'87 to '89, when I first came here, I |
think there were plenty of people to |
do the job, to do the NASA job. -#

INTERVIEWER: Right.

#-STRUCTURE
SUBJECT: Both within the aerospace -#
industry and within NASA itself, |
$-FLATTER
there's been considerable |-$
downsizing--is that the right word? -# -$

INTERVIEWER: Uh-huh. Consolidation;
yeah.

SUBJECT: There's all kinds of words
for it. Reengineering; whatever you
wanna call it.

INTERVIEWER: Yeah. They sometimes don't
say what actually happens,
#-STRUCTURE
unfortunately. SUBJECT: Yeah. But -#
$-FLATTER
the bottom line is that today there |-$
%-MOREWORK
are much less people at NASA, and our |-$-%
mission really hasn't decreased in my | |
opinion, you know, NASA's mission as a | |
whole, and so people are--I mean, it's | -%
$-MOREWORK
starting to show. People are |-$
stretched pretty thin, and I'm not |-$
saying--I wouldn't go as far as saying |
we're stretched too thin, but we're |
pretty close to that boundary. -#

INTERVIEWER: Is that boundary--you
think that's pretty clearly defined
or–

#-STRUCTURE
SUBJECT: No; no. It's a gray boundary -#
and it's a boundary that's different |
for every project. Well, you know, |
examples, an example I would use is in |
the Mars program. It's a pretty |
%-COST
well-publicized example. Pathfinder | -%
cost 1/20th of Viking, even inflating | |
Viking's cost to Pathfinder | |
dollars--1/20th--and was highly | |
successful. We then cut the cost by | |
another factor of two, in doing both | |
Mars climate orbiter and Mars polar | |
lander. -#- %

INTERVIEWER: Right.

#-COST
SUBJECT: I mean, the total cost for -#
those two was the same as Pathfinder. |
So it was two for the price of one, |
basically. -#

INTERVIEWER: Okay.

#-OUTSOURCE
SUBJECT: Plus we did it largely with -#
industry as opposed to Pathfinder, |
$-STRUCTURE
which was done largely in-house at | -$
JPL. -# -$

#-STRUCTURE
INTERVIEWER: Right. SUBJECT: And -#
with the NASA centers' involvement. -#
#-RESULTS
And I think, you know, that showed. I -#
mean, I think Pathfinder was really |
pushing the edge of what was feasible |
in a project like that. I mean, there |
were all kinds--I remember being—you |
know, I was a part of Pathfinder for |
about five years, and I remember the |
whole time, people telling us we were |
crazy, we couldn't do it, there was no |
$-COST
way. You know, and we were all, |-$
everybody was real happy when it | |
worked, but the response to that was, | |
well, okay, do it again, here's half | |
the money, and I think that showed. -# -$

INTERVIEWER: That's an interesting
observation. Where was the "do it
again for half the money"? What drove
that? You know, where do you think
that came from?

#-FLATTER

SUBJECT: I think it came from the top, I think from faster, better, cheaper, and trying to define—it didn't come directly from Mr. Golden. I wouldn't say that. It came from the way people interpreted Mr. Golden, and it came from the pressures that the agency was under. I mean, do more with less. And, basically, you know, it's like you say, this boundary between having a streamlined, efficient organization, and having an organization that's overstressed, and dysfunctional, is not a clear boundary, and I think the boundary in this case, for Mars, is somewhere between Pathfinder and Mars polar lander.

INTERVIEWER: Sure.

#-COST

SUBJECT: Don't know if it's--you know, if you cut 10 percent of Mars/Pathfinder budget, would that make a difference? You'd probably pull that off. Clearly, if you cut it in half, that's probably cutting it too far, and somewhere in there is a boundary. But there was no data at the time, to really know that it was too far.

INTERVIEWER: Sure.

#-METRIC

SUBJECT: I mean, there were indications throughout the project, but it was kind a hard to stop once it got started.

INTERVIEWER: Well, it seems to me that–

#-RISK
SUBJECT: And so now, you know, -#
they're going--the pendulum has swung |
the other way, if you will, for the |
Mars program, and the other three |
missions are probably taking a little |
bit less risk than Pathfinder, or |
$-COST
they're at least supposed to be. But -# -$
they have more funding than Pathfinder |
had. So if you look purely from a |
dollars perspective, Pathfinder was |
here, where MPL was half the price and |
it didn't work– -$

INTERVIEWER: So now the bracketing.

#-COST
SUBJECT: Now we're saying, well, -#
let's be a little more conservative. |
So they're actually on the other side |
of Pathfinder. The Mars exploration |
rover project, the 2003 project, has a |
little bit more money than Pathfinder. -#
INTERVIEWER: Well, you know, take a
step back and when you look at faster,
better, cheaper, you know, I always
ask this question because I get
different, sometimes I get different
interpretations. But what would you
define each of those terms as? I
mean, the faster's pretty clear, I
guess, and the cheaper's pretty clear.

SUBJECT: Yeah, actually, I mean,
#-BETTER
that's a good question because I think -#
it's been interpreted by different |
people different ways. I think that's |
a part of the problem. People tend to |

lose sight of the word better, because |
$-FASTER
they can't quantify it very well. I -# -$
mean, faster is real clear; right? You |
just look at the schedule, and how |
much faster were you than the previous |
%-CHEAPER
guy. And cheaper is real quick, do it -$-%
easy--you look at the dollars, and how |
much cheaper were you. Some of the |
people I know in industry refer to |
faster, better, cheaper as cheaper, |
#-INTERACT
cheaper, cheaper. Other folks I know -# -%
like to add a little phrase at the end |
and they say faster, better, cheaper, |
pick any two, 'cause you can't have |
all three. I actually disagree. I -#
#-INTERACT
think you can have all three. I think -#
we had all three on Pathfinder, and I -#
#-INTERACT #-LEADERSHIP
define "better" as never accepting -#
what you have as good enough. Always |
challenging it, always saying, What |
if?, always asking questions, always |
pushing just a little bit better. -#
Just, you know, at some--within the
cost and the schedule constraints that
#-INTERACT
you have as a project. So, up front, -#
you can define faster and cheaper by |
saying this project, instead of taking |
seven years, is gonna take three, and |
instead of costing a couple billion |
dollars, is gonna cost $250 million. |
That's kind of what we did on |
$-LEADERSHIP
Pathfinder. And then "better" is up to | -$
the project team. Within those | |
constraints, the project team has to | |
always be pushing, and, in my opinion, | |
should never turn in their deliverable | |

early, and should never turn in their
deliverable with any money left over,
because those things have already been
cut–

INTERVIEWER: Right; right.

#-BETTER
SUBJECT: --in the beginning, and
that's the box that you have to live
with. And "better" is, you know,
always saying, well, what if we come
in--for Pathfinder--what if we come in
and there's a dust storm? or what if
we come in a little bit steeper? Can
the system handle that? You know, not
designing your system just to work
within the requirements, but to work,
you know, even outside the
requirements, so you have margin to
handle some of the unknown unknowns.

INTERVIEWER: Taking another, or a
little different look at risk, I
guess, huh?

SUBJECT: Yeah, and I think that the
Pathfinder team, that was led by Tony
Spear from JPL--hey.

INTERVIEWER: Yeah, on the Pathfinder
with Tony Spear.

$-LEADERSHIP
SUBJECT: Yeah. Tony did that. Tony
really understood what faster, better,
cheaper was. He really did, and I
don't think a lotta people do, and he
pushed it on the team. I mean, he made
the team live it, breathe it, smell
#-INTERACT
it, eat it--the whole thing. I think
on Mars polar lander, I don't think

they really got it. I don't think they got what faster, better, cheaper was. They got the fact--in their case, their box was tighter than ours. They had the same schedules. They were just as fast. But they had much less dollars, and they had, in my opinion, a harder challenge because of that. But they worked to the requirements only as far as I could tell, and they didn't really push outside the requirements box very much. They didn't have a lotta extra testing 'cause they couldn't afford it, and some of that was probably prudent, and probably should have been raised up, and someone should have said, "Hey, look, you know, we're taking a little too much risk." I mean, there needs to be a balance. That's what risk management, you know, is all about, is balancing, you know, faster, better, cheaper. You could think of it that way. Risk management is a balancing schedule to be faster on equality, if you will, or margins, which would be better, and dollars, which would be cheaper.

INTERVIEWER: What about your--talking about the project team, and, you know, you had a pretty--when you're with Pathfinder, they had certain things going on, I'm sure, that made them cohesive. You know, concentrating the location in one place, everybody working together, and so forth. But you've got other, you know, you've got a lot of other stakeholders, and a lot of other people that work, that have something to do with the deliverable, in functional areas, such as you've got finance folks, you've got procurement folks, you've got whatever it may be. What do you think about that definition of "better" for people who aren't in the mission side, that don't see the qualification–

SUBJECT: It's still there.

INTERVIEWER: Is it?

SUBJECT: It's still there. It has to
#-STRUCTURE
be. Well, I mean, co-location is important, I think, and you want to co-locate your central personnel, and, if possible, you want to include as many people as you can. But co-location, by itself, is not the answer to project management woes.

INTERVIEWER: Sure.

$-BUY-IN
SUBJECT: I think the real answer is getting people emotionally attached to the program, to the success of the program. Getting people to buy in, whether they're the engineers, the technicians, or the business side of the house, they gotta understand how their job relates to the mission success, and they gotta feel like they're a part of the program. If they don't feel like they're a part of it and they're making valuable contributions, and that without them the whole thing is gonna fall, then, you know, they're probably not gonna give it their all. And that's the one thing I've noticed. I mean, here, at NASA, especially right now, there's so many projects. The only hope that a good project manager has is to inspire

everybody on their team, that his particular project is the most important thing in the world, and Tony was great t that, too. If you can do that, whether the person's, you know, in a different building or at a different center, if they feel like without them the project isn't gonna happen, they tend to have some ownership in the project, some buy-in, and they will do, you know, remarkable things, much more--probably much more amazing things than you would have ever thought possible, and I see that all the time, not just on Pathfinder. I mean, that happened, you know, on the EEV [ph] project, where we didn't have a co-located group of people, and that's happened here in ISE also. I mean, the ISE Program, the team itself was relatively splintered, and semi-dysfunctional, you know, when I got here, and the team now is, you know, is really starting to act like a team, and this is a team that's not co-located, it's got people at different centers, and–

INTERVIEWER: And why is that?

#-BUY-IN

SUBJECT: It's hard to actually put your finger on one thing but it's--you've gotta have a plan, you've gotta have enthusiasm, the plan has to make sense, it has to fit into--you know, what are the long-range goals? People all have to come into agreement that these are the right long-range goals, and–

INTERVIEWER: Sounds suspiciously like leadership.

#-BUY-IN

SUBJECT: There you go! This is something that is worth investing my time. I mean, a lotta people are gonna end up working nights and weekends, you know, away from their families. There has to be--you can't make people do that, particularly in the Government. People have to wanna do that, and so, yeah, up front, leadership, setting the right leadership tone, you know, creating an energy within the program is--is vital. It's what every good project manager needs to do. And that's really the key. That's something that I've always focused on.

INTERVIEWER: What do you think is the state of that sort of ability or capability of project managers across NASA, in general, if you were to just take a snapshot and say, hey, look, you know, this is kind of the way that it looks to me right now.

#-CULTURE

SUBJECT: I think that it's very personality-dependent right now. I think that, at NASA, right now, there are a lotta good leaders, but those are--the good leaders tend to be born, and that we need to pay a little more attention to developing good leaders. I don't actually believe that to be a good leader you have to be born with those characteristics. I believe that, you know, an average leader can become a great leader with good development, good training, but I don't know that, at NASA, not necessarily at Langley but at NASA, in general, that we really focus on leadership. We tend to focus more on management, you know, and management's important–

INTERVIEWER: Are you talking about the scheduling and the measurement, and the organizing and the placement–

SUBJECT: Yeah, but that's not–

INTERVIEWER: --aspect? Okay.

#-CULTURE

SUBJECT: It's easy to develop a good manager, someone who knows what to track, and, you know, does the tracking, and stuff like that. It's easy to develop. Well, it's not easy, but people can be developed into good human resources managers, but it's hardest to develop, I think, you know, a really exceptional leader, and if there is a hole in NASA's training and developmental kind of programs, it's probably in the leadership area, although I know that we're gonna fix it. I just--you know, it takes a little while.

INTERVIEWER: In comparison–

SUBJECT: It certainly wasn't there ten years ago.

INTERVIEWER: Yeah. That's interesting. You mean the gap wasn't there, the leadership–

SUBJECT: No; the training.

INTERVIEWER: Oh, the training; okay.

SUBJECT: Because I mean I would have

tried to get into a program like that
and there wasn't one available.

INTERVIEWER: In your collaborative
efforts with other organizations, what
observations have you, in talking with
your peers, and in looking at
others--what observations have you
made in their similar efforts? It's
not called faster, better, cheaper
with them. It's probably called
something else. Lean design; whatever.
!-INTERACT
!

SUBJECT: Go outside a NASA.

INTERVIEWER: Yeah; outside of NASA–

SUBJECT: Yeah; that's right.

INTERVIEWER: --and outside of NASA, in
Government–

#-INTERACT
SUBJECT: At Boeing it's called "lean -#
and efficient." -#

INTERVIEWER: Okay.

SUBJECT: In the Army, they call it--I
can't remember. They have a different
phrase for it. Everybody has a
different phrase. I mean, what I see
is it's--I don't know,
internationally, but at least
#-SIMILAR
nationally, it's a trend all over, not -#
just in aerospace. Everybody's |
$-STRUCTURE
downsizing. Everybody's been | -$
consolidated, particularly in the | |
commercial sectors. You know, | |

everybody's being merged and bought, and is trying to do more with less, which is really another way of saying faster, better, cheaper. So, I mean,

#-RESULTS

you see it all over. I think it has been applied within NASA very well, and I think that we have been a little unfairly criticized for recent failures. I mean, we need to be criticized for the failures, but I don't think that the failures should be a death toll for faster, better, cheaper. I think faster, better, cheaper is the right thing to be doing for NASA, and you can see the advantages that it's having outside. You can see how Boeing is first in saving all kinds of money, how the Army and the Air Force are doing the same. INTERVIEWER: Right.

#-RESULTS

SUBJECT: So I mean I see it--it's happening everywhere, and it needs to happen for people to remain competitive, and in the Government it needs to happen just because, you know, everybody wants to reduce the size of the Government.

INTERVIEWER: Sure. Government reinvention, that sort of thing.

#-METHOD

SUBJECT: It does happen a little differently everywhere. I mean, you know, in industry, one way to do it is you can just fire 2000 people. In Government, you can't really do that without an act of Congress! But it's being done, nevertheless, even in the Government.

INTERVIEWER: When you take a look, organizationally, at NASA, the way that it's structured, I mean, you know, you've got various centers, Langley has its particular way of doing business, you've got a headquarters that's up in Washington, D.C., and you have an awful lot of contractors out there, that you provide oversight, and insight to, I would imagine. In that sort of an environment, what do you see as barriers and opportunities in doing faster, better, cheaper?

SUBJECT: It is a problem.

INTERVIEWER: Is NASA optimally structured to do that?

#-STRUCTURE
SUBJECT: No. The agency, as a whole, does not function as a great team, and you can see that across the NASA centers, you can see that across the five strategic enterprises. I mean, kind a any way you split the apple, the pieces don't talk to each other
$-TECHNOLOGY
real well. The financial systems of each center is different, so in a program like ISE, where we're sending money to every NASA center, it becomes a problem in tracking the funds, and
#-STRUCTURE
the people--because of all the downsizing, there's a natural competitiveness among the centers, particularly--you know, the Code R centers all squabble, the Code M centers squabble and--you know, 'cause they're fighting for the same piece of

a small pie. Then, on top of all -#
#-STRUCTURE
that, then we're trying to do teaming. -#
You know, we're trying to reach out |
and actually work together. So at the |
worker level, you don't actually see |
much of the politics. You don't see |
the fighting between the centers so |
much, and it's generally true, I |
think, that at the worker level |
everybody wants to work together, and |
that's a big advantage. Also at Mr. -#
Golden's level, he states all the time
that we are one agency, and we're
#-TRUST
gonna work together. The problem is -#
actually in between, you know, with |
$-COMPETE
the senior management, even at | -$
headquarters, and the senior | |
management at all the centers, and | |
then the middle managers at the | |
centers, that they've been kind a | |
scarred from years of infighting, | |
almost. So they have a natural -# -$
#-TRUST
aversion towards relying on another -#
center, and so this is the kind of |
thing--it does make it difficult--but |
this is one of the things that ISE is |
trying to overcome. I mean, we -#
are--we're truly an agency program.
We've set ourselves up that way. If we
can't work as an agency team, we will
fail, and we have made that very clear
to every person on the team, that when
they're on the telecoms, or when
they're doing the work, they don't
represent Langley or Ames, or whoever.
#-BUY-IN
They represent ISE. ISE hat first. -#
Center hat second. That kind of thing. -#

INTERVIEWER: Okay; yeah.

SUBJECT: I mean, it's something that
we've been very open and honest about
in our, you know, team discussions.

INTERVIEWER: Sure.

SUBJECT: We've also had a lotta team
building kind of exercises, events, if
you will, where we all hang out
together, because on a team like ours,
where you're scattered all around the
country, I mean, you don't really need
to be able to see each other on a day
$-STRUCTURE
to day basis, but it really does help -$
to know what the other person looks |
like, to go and have a beer, or |
something with the other person. I |
mean, it really does change things. I |
would say that the agency, as a whole, |
is not functioning well as a team. I |
would say the agency is not actually |
even structured to function well as a |
team. You know, an example I would |
have is, at the enterprise level, is |
#-COMPETE
there's Code M, human exploration and -# |
development of space, and there's Code | |
S, space science, and they're both | |
interested in going to Mars. -# -$

INTERVIEWER: Sure.

SUBJECT: Code S is going there now,
with all the robotic missions. Code M
would like to go there some day with
#-STRUCTURE
human missions. If we were really -#
serious about exploring Mars, there |
would be a Code M called Mars, and not |

called--not the current Code M but a different Code M.

INTERVIEWER: Right.

SUBJECT: And you would have--you know, you would have that–

INTERVIEWER: A concerted effort of robotic and–

#-COMPETE

SUBJECT: Right. You'd have a unified effort. But to do that is very disruptive on other things that Code S, the current Code S and the current Code M are doing.

INTERVIEWER: Right.

SUBJECT: You know, so that's--and there's actually been some discussion of unifying those codes towards the exploration of Mars.

INTERVIEWER: Interesting.

#-COST

SUBJECT: You know, but the other thing that happens a lot is, you know, when there's an overrun, say a station is over budget, or, say, you know, the shuttle, or any program is over budget, the administrator doesn't always--he rarely, actually, restricts that budget cut to that code. So if Code M is over budget, and it's a high-priority thing, like the station or the shuttle would be–

INTERVIEWER: Share the pain.

SUBJECT: Oh, it's not even share the

pain. Somebody else takes the pain. You know, Code R, let's say, or Code S, will lose, you know, whatever the budget is, for this other code to fix,

$-MISSION

'cause, you know, I mean, within NASA, even though we have these different codes, there are priorities. Shells are probably a first priority. Basins probably a second priority. I would guess that Mars exploration looks probably better, and down the line.

#-BUY-IN

But when you do stuff like that, you know, it doesn't build a team, because the people that lose the funding don't have any ownership of what the funding goes towards. It's not like they all of a sudden get to work on, let's say, the space shuttle. They just lose half a million dollars, or half a billion dollars, or whatever, which to them basically means a lotta cuts in their program, in their work. But then they have to deal with that, and that's a painful process. Meanwhile, these other guys, they don't even know, NASA is so big and so dispersed, they get their funding and they get their

#-BUY-IN

problem fixed. So if you're on the receiving end of that, it's great, but, more often than not--or sooner or later you'll be on the giving end of that. And so sooner or later, over the course of your career, even in just ten years, you'll grow to hate that, and you'll grow to--so that doesn't build a team. That's all I'm trying to say.

INTERVIEWER: Sure; sure.

#-BUY-IN
SUBJECT: Now one way to fix that -#
would be just through communication. |
I mean, like in ISE, for example, when |
there is a budget reduction, we |
discuss it, openly. We explain why |
the reduction came, where it came |
from, how we dispersed it, who was |
affected, why we chose those people to |
take the cut, why we didn't choose |
these other people, and we explain how |
these other people who've had their |
budgets reduced, how they can work |
with the other people that need--have |
the priority to help. And we try to |
realign the program around the revised |
$-TRUST
budget profile. Now, within the agency -# -$
that's harder to do 'cause it's |
bigger. But that type of free and |
open communication doesn't exist. |
What happens instead is somebody at |
Langley, let's say, just gets a |
million dollar, $10 million budget |
reduction. Somebody at Johnson gets |
the money and you really don't even |
#-C'MUNICATE
know why. I mean, and if the -# |
priorities of the agency were | |
accurately communicated, I mean, the | |
decision probably makes sense. It's | |
not that they're just doing it | |
randomly, and arbitrarily. -# -$

INTERVIEWER: Right, but it really
doesn't get out there–

SUBJECT: It rarely gives out what the
real reason was, you know, and I would
think that if the answer was this No.
1 priority project had a cost overrun,
#-TRUST
it's our No. 1 priority, if you -#

explain that to this other group that
$-C'MUNICATE
was losing the money, they would probably be--they wouldn't be happy but they would probably be okay with that. They would at least understand, and they might feel more a part of the NASA team. INTERVIEWER: Right. It's interesting that you brought up--I know you're going up to see Sam Veneri ; right?

SUBJECT: Yeah. I'm–

INTERVIEWER: It gives him a better understanding of what exactly it is that your project is about, and I guess that goes along with what your philosophy is, which is that communications, right?

SUBJECT: Oh, yeah.

INTERVIEWER: I mean, that comes with everything. You know, you've got budget cuts coming, but if people don't understand what you're doing, I guess it's easier to slice off the budget.

#-TRUST
SUBJECT: Yeah. Well, communication
$-C'MUNICATE
has to go lots of different ways. You want communication from headquarters to the centers, but it's the centers' responsibility to make sure headquarters is informed of what they're doing.

INTERVIEWER: Right.

#-TRUST $-C'MUNICATE

SUBJECT: You know, you hear--there
have been several examples, recently,
where a project will get all the way
downstream, like almost ready to
launch, and somebody from headquarters
will do some review, and they'll say,
"Well, wait a minute. You can't do
that. That's against such and such a
policy." And the project manager will
say, "We made that decision a year
ago. Where were ya?" And well, you
know, and so the whole thing comes to
a screeching halt. Whose fault is
that? It is the project manager's
fault because he didn't tell
headquarters, or is it headquarters'
fault 'cause they weren't there a year
ago? I mean, I think it's–

INTERVIEWER: Tough call.

SUBJECT: I think it's both.

INTERVIEWER: Yeah.

#-TRUST $-C'MUNICATE
SUBJECT: But I do think that at the
centers, we have the responsibility
for keeping headquarters informed.
They need to be informed of what their
money--I mean, they're the ones that
appropriate money, basically. They
need to be informed of what their
money is buying now, and they need to
be informed of the risks that we are
taking to get their job done.

INTERVIEWER: In your planning, then, in
doing faster, better, cheaper, where
does that fall? I mean, let's say you
had a project plan. Where do you put
that–

SUBJECT: Where do you put your communications? INTERVIEWER: Yeah. Where do you put it?

#-C'MUNICATE
SUBJECT: That's just a part of project management. You know, I would budget it, I would budget the time in the work breakdown structure under project management. You know, usually, there's a section called project management, or systems engineering, and they need to be, you know, structured–

INTERVIEWER: So you put it under just the general project management activity as communications activities, and contact stakeholders, and–

#-TRUST
SUBJECT: Yeah. I would call it--yeah,
$-C'MUNICATE
I would actually it something like risk communications or something, because you need to communicate the risk to headquarters, that you're taking. Should they do such and such, this is how it will impact the program.

INTERVIEWER: Right.

SUBJECT: We won't deliver this product to this customer. This customer will scream to Congress. Congress will come back and yell at
#-C'MUNICATE
you. You know, you can tell them that, up front, with some clarity. I think, you know, it makes everybody's life easier.

INTERVIEWER: In your opinion, looking
at project plans and project planning,
and activities that you've seen across
NASA, in your whole career, how often
does what you're talking about happen?

#-TRUST #-LEADERSHIP
SUBJECT: It's all personality-driven.
I don't think it's–

INTERVIEWER: So it comes back to–

SUBJECT: --part of--I don't think
it's actually written down as a
responsibility of a project manager,
or if it is, you don't see it in a
program plan or in a project plan. You
#-TRUST #-LEADERSHIP
don't tend to see that. There's a
bunch of intangible things that have
to be done as part of, I guess,
program leadership, and those things
tend not to be written program plan or
$-LEADERSHIP
project plan. What you tend to get in
a project plan is just, you know,
these are the milestones, this is the
schedule, these are the deliverables,
this is the funding that we need--that
kind of thing--your technical
description of what you're gonna get.
But you don't get that--well, I guess,
in some, there'll be a description of
the reviews and the reporting process.
That's understandably entwined. But,
you know, there's not--I go back to
#-TRUST #-LEADERSHIP
Pathfinder once again. The reason
that Pathfinder--one of the reasons
that Pathfinder worked so well is Tony
Spear had a personal relationship with
Wes Hundress [ph] who was the AA for

Code S at the time, and Wed gave him the money and got outta the way. And he said, "Tony, I want you to land this thing on Mars, take that rover off, take one rover sample, and send one picture back. That's all I want for this money. And if you do better than that--great. But this is--that's your minimum requirements."

INTERVIEWER: Interesting. SUBJECT:

#-TRUST $-LEADERSHIP

And he got outta the way. And that rarely happens [inaudible]. Not only did he get outta the way. He made sure that Tony got his funding, on time, every year. He made sure that any issues that--you know, when Tony had a problem, he'd call up Wes. Wes would take care of it. I mean, that kind a stuff rarely happens. But that enabled that mission to work in, you know, the three-year development schedule and stuff--having that type of--but that's

$-LEADERSHIP

a personality-dependent thing. They had a personal relationship from working together for years. They

#-C'MUNICATE

tried to see each other. There is not a strong sense of trust between headquarters and the centers because of all the cuts, and because of the downsizing at headquarters and elsewhere. Because of poor communication between headquarters and the centers. You know, like I was saying, people don't understand why headquarters does a certain things, and headquarters doesn't understand why the centers do a certain thing.

INTERVIEWER: And nowhere can you go to

read about why.

#-TRUST

SUBJECT: Yeah, and so without that trust, you know, it's very hard--it makes it harder to get the job done, particularly faster, better, cheaper.

INTERVIEWER: If I were doing faster, better, cheaper, if I were a project manager and I wanted to do it, where would you point me to study up and get down the basics on how to do faster, better, cheaper in NASA?

SUBJECT: I'd point you to Tony's report. That I guess there was a–

INTERVIEWER: Tony Spears' FBC report?

SUBJECT: Tony Spears' FBC report.

INTERVIEWER: Okay.

SUBJECT: That was within NASA. Outside of NASA, there was also a report by the--the guy at Rand Corporation, which I think is referenced in Tony's report, that talks about basically the same thing in the aerospace industry.

INTERVIEWER: Right.

SUBJECT: How they're doing. But I think Tony's report--I was part of the team that put together that report. There was a whole bunch of people from a lotta different centers that worked on it. It wasn't just Tony writing stuff down. He's actually not a very good author.

INTERVIEWER: I was at a couple of his meetings. It was fun.

SUBJECT: Yeah. He's all over the place.

INTERVIEWER: Yup.

SUBJECT: But I thought that report--it didn't get much press 'cause it came out at the same time that all failure reports came out.

INTERVIEWER: Right.

SUBJECT: But I thought it was a pretty accurate report.

INTERVIEWER: Yeah.

SUBJECT: The other thing I have, that I like, is, well, there's a lot. Brian Muirhead's Pathfinder--

INTERVIEWER: Right. Oh, the book? Read it. Yup, leadership . SUBJECT: It's easy, it's small, and it just has these little succinct chapters.

INTERVIEWER: Kind a like the clipped notes for the book.

SUBJECT: Clipped notes; yeah. That's what it was. [Laughter.]

SUBJECT: Anyhow, both the book and that are really good, and Donna Shirley wrote a book that I also think is really good. It's called "Managing Creativity."

INTERVIEWER: Yeah. I read her book; yeah.

SUBJECT: And I think they're all very accurate depictions of the Pathfinder, and of what worked on Pathfinder in terms of faster, better, cheaper.

INTERVIEWER: Okay.

SUBJECT: And within NASA, you have to remember, within NASA Pathfinder, while it may not have been the greatest thing ever--I mean it had its problems--but Pathfinder is still the hallmark within NASA for faster, better, cheaper. When people think of that, they tend to think of the Mars Pathfinder mission.

INTERVIEWER: Sure, and the public, I think thinks of it that way, too. I mean, it was quite a thing to wake up and see in the newspapers the panorama of Mars; yeah.

SUBJECT: I mean, some of these other books I think are good, too, you can get on project management–

INTERVIEWER: Sure.

SUBJECT: --[inaudible]. I think Brian's books and Tony's reports, and
#-INTERACT
Donna's book, I think they really capture the spirit of what it was like to be, you know, on that team, and how we--it's true that we looked at those three things all as equal. It wasn't that coming in under cost is the most important thing. INTERVIEWER: Right.

#-INTERACT

SUBJECT: Which is how MPL [ph] was run. The most important thing on MPL was coming in under cost.

INTERVIEWER: Interesting.

#-INTERACT

SUBJECT: The most important thing on Pathfinder was getting the job done right, which meant coming in within budget, on schedule, but having a robust [inaudible] as reliable as we could make it system.

INTERVIEWER: So balance–

SUBJECT: Yeah; it is a balance.

INTERVIEWER: Yeah. How did your life change? I assume you were still in the sample return thing when the failures occurred with the other programs; right?

SUBJECT: Yeah.

INTERVIEWER: How did your life change as being in that program, in a faster, better, cheaper approach, when the failures came through? What did you notice?

#-MOREWORK

SUBJECT: Oh, it was a mess! Well, actually, what happened was, for me, when Mars climate orbiter failed, the next day I got a phone call, and I went from being on Mars sample return to being on Mars polar lander team.

INTERVIEWER: Interesting.

SUBJECT: Here's a picture. I keep this for a reason, to remind me. This

is in the control room. This is a
Mars bar [inaudible] I've been given
two of those now, one for
Pathfinder--you eat 'em in Operations
after a successful landing. And that
one for MPL which I had in my shirt
pocket, which I've never eaten, and
never will.

INTERVIEWER: Right.

#-MOTIVATION
SUBJECT: But I spent six weeks, -#
basically the time between the Mars |
climate orbiter failure and the Mars |
polar lander, what turned into a |
failure--spent six weeks working with |
$-MOREWORK
JPL. They pulled in everybody they | -$
could to help. -# -$

INTERVIEWER: Right.

#-MOTIVATION #-MOREWORK
SUBJECT: And I ended up being part of -#
the landing operations for Mars polar |
lander also, even though I wasn't part |
of the development– -#

#-MOTIVATION
INTERVIEWER: Sure. SUBJECT: So I was -#
on Mars sample return, I jumped to |
$-MOREWORK
MPL. I had to come up to speed on all | -$
that stuff. It was very stressful. | |
Then I was actually a part of the | |
failure itself, which was--you know, I | |
was working like 70 hours a week for | |
those six weeks, and I was concerned | |
before the entry, but, you know, I | |
mean, what can you do– -# -$

INTERVIEWER: A little too late.

#-MOREWORK

SUBJECT: Well, we did everything we honestly--we actually--there were a number of problems that we fixed in the last days before the entry. We did software patches and things like that. But there were some things that you just couldn't fix, and some things that we didn't catch. Like what ended up being the most likely cause of the failure, we didn't catch till after the–

INTERVIEWER: Sure.

SUBJECT: So then I was a part of that, I was up for basically

#-MOREWORK

overnight, working. I worked on the navigation team, so I usually--on both Pathfinder and MPL, I was up all night, the night before the entry, at the computer, you know, doing work, and then you're part of the actual operations itself. You can sit in the control room and stuff. And then on MPL, when it failed, then I was a part of the Mars polar lander review--one of the review boards. The Casani review board.

INTERVIEWER: Yeah; yeah.

#-COST

SUBJECT: I was a part of that team, just a small part but--and it was very

$-MOREWORK

stressful. It was probably the most stressful part of my career, not because it failed but just because there was so much to do in these six weeks, because they were so

underfunded, really. They were behind on everything, and, you know, it
$-LEADERSHIP
should have--somebody should a noticed earlier, but, for whatever reason, it didn't happen.

INTERVIEWER: Different pressures.

SUBJECT: Yeah, and I was working with folks back here, at Langley, who were
#-MOREWORK
helping while I was in JPL. They were under a lotta pressure, and we were screaming at each other over the phone and stuff. None of us slept. I mean, we're all friends now, but it was a very stressful time. You talk about some pressure. I mean, you go to these reviews, like an operations readiness review, like the day before entry, and you still have all these open issues, and it's in front of JPL senior management and they're asking really hard, penetrating questions like they should. NASA headquarters was there. I mean, there was--we did a maneuver, a few hours before the entry, to get us flying on the right trajectory 'cause we were off, and that was something we hadn't had to do on Pathfinder. That was a big thing, involving the navigation steam, and
#-MOREWORK
stuff. And then after MPL failed, I had to deal with the media.

INTERVIEWER: I remember all that happening. SUBJECT: In fact what happened--this is kind of a funny story. I was up all night, the night before. When it didn't land, my job was basically over anyway 'cause I have to do with the landing, and we didn't hear back from it, I told Rich Cook [ph], who was the mission manager at the time, I told him that I was gonna go home and get some sleep. He said fine. And I passed out and I didn't know anything. And then I told him I'd be back at 7:00 the next morning. So I come back at 7:00 the next morning and I go into this control room, and it had hundreds of people in it, and there's not a single person there, and I'm just sitting in there, and I said, "Well, I better just start working. I'll clean up my stuff." 'Cause I was supposed to fly home the next day, 'cause we were gonna be successful of course. So I started packing up my stuff, and, you know, I'm cleaning up. At about 9:00 o'clock the pone rings and it's Richard. I say, "Hey, did we find it? Everything's good?" He goes, "Well, if everything was good, you wouldn't be the only person in the control room right now." And I said, "Well, how do you know I'm the only one here?" And he says, "Well, you're on TV."

INTERVIEWER: Oh, my God!

SUBJECT: And so I'm on TV packing my boxes. Then he says, "We were up till 2:00 in the morning last night, you know, doing stuff, and I gave everybody the morning off because local Mars time"--you know, the sun hadn't risen off Mars yet, and so there wasn't anything they could do till the afternoon anyway. And I said, "Oh, okay; great. Well, I'll just be here when you guys get in."

#-MOREWORK

And he said fine. And he goes, "Well, you know, you could do me a favor." And I said, "What's that?" And he said, "I'm really tired. I need to get some sleep. I just got a call from our public affairs people and the press.

$-CUSTOMER

They need somebody to talk to. Would you go down and be spokesperson for the project and talk to the press." And I said, "Sure. What do you want me to say?" And he told me, you know, where--he gave me like a half hour data dump on the status, you know, what had happened the night before while I was out. And I go down there and I was basically the only person from the project team that was around, and they had a square area where all the press was, all around the square, and they had a big model of the lander

$-CUSTOMER

in the middle, and the public affairs guy started me at one corner, and had about 50 press people set up around that thing, and I went from guy to guy, you know, camera to camera to camera.

INTERVIEWER: Right.

SUBJECT: They did the right thing. They started me out like, you know, some little podunk station in West Valley, Tennessee [inaudible]; you

#-CUSTOMER

know? And the last four interviews I did were CNN, NBC, ABC, and Fox. I remember asking the NBC person, I said, "NBC, what city, NBC? What local station are you with?? And she goes, "Oh, no. This was NBC Nightly News, Tom Brokaw. You're our lead story."

And I was like "glad you told me that after the interview." I was wearing jeans and my Stanford sweat shirt.

INTERVIEWER: There you go!

SUBJECT: And I was on about--ended up being--not everybody used my clips, but I ended up being on at least 15 stations, and MSNBC. INTERVIEWER: Yeah.

SUBJECT: I had had a lotta press exposure on Pathfinder, but it was all real. I mean, I could say almost anything 'cause it was such a huge success. All they wanted–

INTERVIEWER: Yeah. Pleasant experience.

SUBJECT: All they wanted was some guy smiling, you know, and laughing at the camera and stuff. And on MPL, I mean, it was much different, particularly the Fox people were digging for all kinds a--"Well, that means the mission's over; right? We've clearly lost a spacecraft." You know, questions like that, which, at the time, we had no info--we really thought that the spacecraft was--there was a possibility at least that it–

INTERVIEWER: Sitting there on--yeah.

SUBJECT: I wasn't gonna say anything like that.

INTERVIEWER: Sure.

SUBJECT: But it was a very different experience, and then after that I came

back here, and it's been very
#-RISK
different ever since. People are very
$-LEADERSHIP
concerned, now, with risk. I would say
the pendulum has probably swung a
little too far, and within the Mars
program, at least, I think we're not
taking enough risk.

INTERVIEWER: Right.

#-RISK
SUBJECT: You know, I think Pathfinder
was a perfect balance, and like I
said, MPL was too far, and I think
because of the failures, we're afraid
to fail again, and I think we're
taking maybe not enough risk.

INTERVIEWER: If you were going to
reproduce Pathfinder, let's say they
told you tomorrow that you had to do
this mission again, do you think that
that's doable in NASA, the way that it
is, and the way that things are?

#-STRUCTURE
SUBJECT: Yeah, well, it depends. The
beauty of Pathfinder is that nobody
$-LEADERSHIP
knew about us until we launched. So
we worked in secrecy, basically, and
we didn't make a secret out of it. But
nobody cared. There was very little
press, none of the other NASA centers
really knew about it. It was really
like 95 percent JPL's show, and they
pulled in a couple experts that they
needed from the different centers.
#-STRUCTURE $-LEADERSHIP
Now the way it is is Mars is such a
high-profile thing, all the centers

%-CUSTOMER

want to be a part of it. The press is involved from day one. Basically, you're operating in a fishbowl, you know, in a fishbowl kind of environment, and in that type of situation I don't think you could do anything. But if you would allow me to reproduce the environment that Pathfinder operated in, which was--the team was allowed to be isolated, so they focused on the job at hand, and the sponsor at headquarters was willing to do anything to help us do our job as opposed to, you know, putting up roadblocks and being a poor communicator, and things like that.

INTERVIEWER: And then basically getting out of the way.

SUBJECT: I think we could easily do it again. I really do. I mean, I don't think it was a lucky event. I think it was the product of a good team operating in a good environment focused on the job, and getting the job done.

INTERVIEWER: Do you get very many people talking to you about the "Skunk Works"?

SUBJECT: Yeah; yeah.

INTERVIEWER: Do you?

SUBJECT: What I've read about the Skunk Works--I've never actually been there--but what I've read, the Pathfinder experience reminds me a lot of what the Skunk Works used to be, you know, when they talk about Kelly Johnson, and when he was building the

Skunk Works.

INTERVIEWER: The secrecy; leaving them
alone.

SUBJECT: That's what Pathfinder was.
In fact on some of the very early
Pathfinder charts, we used the little
Skunk Works logo, and we had all kinds
of rallying tries, and that was one of
#-STRUCTURE $-LEADERSHIP
them. Tony was really good, also, at
shielding people. I mean, he took care
of all the external crap, and I mean,
there was much less of it then than
there is now. It takes many more
people, now, to handle all that. But
if you were to start a Mars project,
now, one of your first problems would
be that Ames would have to be
involved, and Langley would have to be
involved, and Johnson would have to be
involved, and Kennedy would have to be
involved, and we were headed that way
on Mars sample return anyway. Mars
sample return was so big, and
Pathfinder had been so successful,
that nobody was going to let JPL just
do it. Marshall, Kennedy, Langley,
Ames, and Johnson all had big roles on
Mars sample return. And I'm not saying
that those centers can't contribute. I
mean, I'm a Langley guy. I think
Langley can contribute quite a bit.
#-STRUCTURE $-POLITICAL
But it's one thing for the project to
request your help in specific areas,
and have you contribute, and it's
another for the political system to
require that this be a multi-center
effort, and, you know, that's what--on
Mars sample return, it was required
that this piece be built at Kennedy

and this piece be built at Marshall, although that's not written down anywhere. I mean, that's pretty much what happened.

INTERVIEWER: Interesting.

SUBJECT: You know, and that was really--that was a straight result of all the success that we had in Pathfinder. But what happened is in doing that, you're not reproducing the environment for Pathfinder, and the environment for a project--you know, the environment that a project operates in is crucial for the

#-STRUCTURE $-POLITICAL

project's success. If you're operating in an environment with political instability or budgetary instability, I mean, those are huge issues that the project manager has to

%-LEADERSHIP

overcome. If you're operating in an environment with political stability because you're hidden or whatever, or because there just is stability, so you're operating--and if you know what your budget is, you can actually plan to it and implement to that budget. These are things that the project manager doesn't have to worry about and he can then focus on leadership, building a team, focus on managing the project, you know, the types of things that he really is there for. Now you need to maximize the value of the project manager, not have the project manager so tied up in the crap work, if you will, you know, that he doesn't have any time to even understand his own project.

INTERVIEWER: Yeah.

SUBJECT: So that thing's kind of going on a little bit in ISE. I mean, you haven't met Wilson 'cause he's not here, he's on vacation, but Wilson handles all the programmatics, the politics, the external factors, if you will, and my job on ISE is to focus on getting the work done, and I--see, I actually see myself on ISE as being in an equivalent job as Tony, even though I'm not the project manager. Wilson is.

INTERVIEWER: Right.

#-LEADERSHIP
SUBJECT: I mean, Wilson's whole job is to shield me so that I can be the project manager, in a way, and, to me, it's unfortunate that you have to operate that way, and most of the Mars projects now have to operate that way, because they're in a fishbowl.

INTERVIEWER: Yeah; interesting.

SUBJECT: So, you know, so the pendulum I think has swung a little
#-RISK
too far, and I think the publicity surrounding Pathfinder's success, and then the Mars failures, has really created an environment where everyone wants to be a part of Mars but yet we're afraid to be a part of Mars.

INTERVIEWER: Right; right.

SUBJECT: It's really hard.

INTERVIEWER: Yeah, and you can see it.

SUBJECT: The guys working on the 03
mission, I think they have the hardest
job in the agency right now, and
that's one of the reasons why I'm glad
I'm not doing that.

INTERVIEWER: Well, do you have anything
in conclusion, or any other thing that
you haven't talked about? What would
you like to talk about?

SUBJECT: Well, I think I'd come back
to just a couple points. I think I
probably touched on it. I think that
the most important part, the most
important aspect of being a project
manager, a good project manager,
#-LEADERSHIP
is--there are two factors. One is -#
really being not a project manager but |
a project leader, a leader who can |
inspire others to do great things, |
will build a team and inspires others |
$-RISK
to do great things. And the second -# -$
most important part of being a good |
project manager is understanding risk |
and how to balance risk, and |
particularly in a better, faster, |
cheaper environment. See, I still -$
believe that we can do better, faster,
cheaper, here, at NASA. I don't think
that the Mars failures prove that it
was a bad idea. I actually think that
they prove that it was a good idea.
It was just taken a little--it proved
what the problem was when it's taken
#-INTERACT
to an extreme, but it's still a good -#
idea, and it's got to be the project |
manager's job to balance risk 'cause |
nobody else can do that. You know, -#

the headquarters guys aren't close
enough to the problem. The technical
people are too much in the details to
see the big picture. So, you know, so
the two most important things, then,
are really, in my mind, being a good
leader, and understanding risk and
balancing risk, and so within NASA, I
think we need to grow our people a
little bit more in those areas, in
leadership and in, you know, risk
balance, or I don't know what--how is
that risk management perhaps–

INTERVIEWER: Yeah.

SUBJECT: It's not traditional–

INTERVIEWER: You know, the risk folks
up at headquarters have an interesting
way to put that. They say, you know,
risk is a resource, and you trade.

SUBJECT: Yeah.

INTERVIEWER: You know, just like you
trade with schedule and cost, risk is
considered as a resource that you
can--you know--that you can use.

#-RISK
SUBJECT: Right. That's exactly what -#
I'm saying. You have to know where you |
are in the risk space, just like in |
the design space. -#

INTERVIEWER: Sure; sure.

#-RISK
SUBJECT: And you have to understand -#
the consequences of each decision. You |
know, do they move you closer to this |
boundary or closer to this boundary, |

and, in the end, you want to be as
close to the center of that box as you
can, because there's gonna be unknown
unknowns that are gonna eventually
move you in one direction or another.
You need to have the robustness to
accommodate that.

INTERVIEWER: Interesting. Okay.

#-MOTIVATION
SUBJECT: But I think--this is the
last thing I would say, is I think
that, you know, working at NASA has
been a dream of mine for–

INTERVIEWER: That's what I hear from–

SUBJECT: --a long time.

INTERVIEWER: --all of the good people.
#-MISSION
SUBJECT: I'm real happy to be here.
I wouldn't trade it for anything, even
in the bad times. You know, even in
the middle of MPL, I wouldn't a traded
it for anything. I do think that the
agency is doing some really good
things for the nation, and is well
worth the taxpayer investment, and,
you know, I feel very fortunate to be
a small part of that. It's great.

INTERVIEWER: Very good.

APPENDIX D: SUMMARY TABLES

Table 3: Summary Table "Doing More with Less"

Axial Category Dimensions	Discussion of "Doing More With Less"	Impact on FBC	Application
"Desired Outcomes"	"Doing More With Less" captures the motivation of why FBC is important to NASA, and characterizes each category element as tied to the customer requirements. The relevant provisional categories share the overall dimension of higher performance and consumption of fewer resources (time, money, personnel). In this systems view, one dimension is that "faster", "better", and "cheaper" are "Desired Outcomes" from the improvements afforded by the management of science within NASA.	FBC is a way to manage the creation of scientific knowledge, the development of space, and the transfer of technology less expensively, resulting in an increase in volume and frequency of data that is achieved more effectively and efficiently through more and smaller missions. The success of FBC depends on capturing improvements to replicate success and progress towards organizational goals that are achieved "faster", "better", and "cheaper".	The dimension called "Desired Outcomes" answers Research Question #1, the meaning of FBC for multiple stakeholders. It is clear that it is not the definition of FBC individually and collectively, but that it has been explicitly discussed and agreed upon by all stakeholders. The Government environment causes NASA to adapt to several conditions as shown in the NASA Substantive Theory, using FBC as a mitigation strategy.
"Balancing requirements and constraints"	Customer and stakeholder requirements occur within defined boundaries for cost and schedule, resulting in a realistic balance between requirements and desires. The expectation of "Better" results or outcomes grows from lessons have hopefully been learned and applied in achieving efficiencies and effectiveness. When a baseline is available for comparison (such as a previous mission), these expectations can be measured, such as *Pathfinder* versus *Viking*.	The trade-offs that occur in pursuit of science in NASA are the essence of managing science versus doing science. The interaction of "faster", "better", and "cheaper" requirements forces a prioritization and leadership behavior that fosters innovation based on the realities of the government project environment. FBC projects depend on consistent expectations and accurate determinations of risk.	"Balancing Requirements and Constraints" addresses Research Question #2, with the interrelationships between requirements and desires serving as a launch point for a realistic discussion between managers and project personnel.

Axial Category Dimensions	Discussion of "Doing More With Less"	Impact on FBC	Application
"Willingness to learn from others"	The lessons that have been learned demonstrate the importance of tools, techniques, and processes applied to the management of science. Most importantly, these tools and methods do not have to be invented within NASA, but are often resisted if they are derived from outside sources.	Advanced technologies and management techniques can be used as enablers to achieve "better", "cheaper" and "faster" results and outcomes. The balance of FBC elements in a management system that results in a reasonable expectation of success and the capture of lessons that allow for replication of these successes form the foundation of this management approach.	This dimension addresses Research Question #2, specifying how technologies and management techniques allow for the achievement of the right balance between "faster", "better", "cheaper". In an environment of downsizing, strategic partnerships become critical so that additional resources can be obtained, key features of FBC Strategy in the NASA Substantive Theory.
"Making outcomes explicit"	The criticality of making results or outcomes explicit and reasonable cannot be overemphasized. Doing more with less is one thing, but doing less with less, and doing less more often, is potentially devastating in an environment of constrained resources. NASA should define these expectations within the system of interactions and trade-offs between "faster, "better", and "cheaper". Thus, risk management becomes an important dimension of FBC, leading to more accurate expectations and realizations of the risk signature and the trade-offs involved.	FBC is defined by smaller missions due to constrained resources, reduction of bureaucracy for faster action, and leadership behavior that encourages innovation. Leadership behavior that encourages innovation needs to occur simultaneously with a sober discussion of what is possible. NASA public professionals love a challenge, and will sign up to do the impossible if there is not a clear discussion of risk and outcomes.	This dimension addresses Research Questions #1 and #2, clarifying the issue of multiple definitions of FBC and miscommunication of the desired outcomes and trade-offs necessary for success between scientists, engineers, operations, and management in an environment of constrained resources. This is one component of the FBC Implementation Actions in the NASA Substantive Theory.

Table 4: Summary Table "Organization and Management"

Axial Category Dimensions	Discussion of "Organization and Management"	Impact on FBC	Application
Transition to New Imperatives"	NASA is rooted in the space race imperatives of the Cold War and the original necessities of creating NASA Centers for political support. Many of the historic ways of doing business persist despite a requirement for more integration, with Human Space Flight receiving the lion's share of resources. The research Centers and the Mission Centers both need attention and resources, requiring cooperation.	The Cold War imperatives of Human Space Flight have given way to the reality of cutbacks. The preservation of political power within the Agency becomes paramount, and includes ideological and budget adversaries who may use administrative efficiency as an excuse to kill programs. This new environment is forcing NASA to live within its means.	This dimension addresses Research Question #3. The Intervening Conditions in the NASA Substantive Theory are outgrowths of historical pressures that have forced NASA to adapt over the years since Apollo. These are at odds with the Government Causal Conditions and the NASA FBC Strategy in the Model.
"Internal competition for fixed resources"	As each Center and Enterprise pursues their mission, communications across boundaries becomes difficult. The overall organization is not optimized to share information and reward collaboration, since each Center and Enterprise is struggling to expand their particular agenda or survive.	FBC programs and projects receive conflicting information through miscommunications at different levels and across the Agency. These conflicting elements prevent a coherent message from emerging, preventing the development of explicit outcomes and accurate mission risk signatures. Since there is no formalized policy of FBC in place, this results in multiple definitions of "better" between operations, scientists, engineers, and managers, which results in miscommunication that can drive inefficiency and ineffectiveness in FBC missions.	This dimension addresses Research Question #3. The historical pressures have created Center cultures that promote independence at the expense of an overall Agency strategy. Unfortunately, FBC has not been defined and Agency policy has not been created for implementation of this approach. Bureaucracies at the Centers contain redundancies and facilities that are not allowing the Agency to adapt to new realities. This contribute to policy ambiguity and works against FBC implementation.

Axial Category Dimensions	Discussion of "Organization and Management"	Impact on FBC	Application
"Reinforcing and Enabling Collaboration"	The rewards and incentives are based at the Centers. Collaborative emphasis across Centers is not mandated by management due to political priorities. From this, the required structures and processes that allow for an integrated approach to missions and research are not developed or are actively resisted. FBC projects that would benefit from a small cross-NASA and contractor team and focused approach are instead mandated to include Centers for political rather than performance reasons.	Centers are not optimally organized and processes are not in place to support FBC projects in a collaborative fashion. NASA public professionals are rewarded for contributing to Center priorities, and the Headquarters was decentralized to the point of becoming ineffective, a reversal from the all-powerful NASA HQs of the Apollo days. FBC programs that depend on innovation and new ways of doing business can be crippled in situations that emphasize political boundaries over mission success,	This dimension addresses Research Question #3. In some instances, the organizational structure sacrifices professional communications, collaboration, and Agency advancement of personnel in favor of Center interests. These political boundaries contribute to policy ambiguity and prevents implementation of FBC strategy.
"Desire to Change"	The employees at NASA want to do a better job, and this was clear through the interview data. Management has not embraced a change from the Apollo days for a portfolio of a prioritized smaller set of NASA programs and projects, preventing a full assessment of the priorities needed to move the Agency forward in an environment of constrained resources. Projects that would benefit from the FBC approach are saddled with political issues rather than performance criteria.	FBC meets with, at worst, active resistance and, at best, benign neglect, with the operational budget often receiving priority, raiding the research and development budget whenever necessary. FBC projects exist under the management constraint of changing priorities and budget instability that make planning difficult. Political conditions and administrative strategy designed to cope with these changes are often not transparent to project personnel.	This dimension addresses Research Question #3. The Implementation Actions in the NASA Substantive Theory are consistently addressed in the data as important for FBC in NASA. These actions can only occur if supported by management through policies and procedures designed to encourage the desired behaviors across the Agency, not allowing for independent interpretation at each Center.

Table 5: Summary Table "Workforce Capability"

Axial Category Dimensions	Discussion of "Workforce Capability"	Impact on FBC	Application
"Public Service Orientation"	"Workforce Capability" addresses the issue that FBC projects require certain types of knowledges, skills, abilities, and attitudes in its workforce to be successful. One dimension of this capability addresses the nature of public service and how public professionals operate under an environment of increasingly constrained resources. As the government shrinks, NASA public professionals must expand their capabilities to ensure that the public interest is secured and be more proactive and innovative for better outcomes.	This key difference between public and private sector project personnel places the guardianship of the public interest squarely with the NASA public professional. If the future of NASA is in public & private sector partnerships, NASA personnel working in FBC programs and projects must clearly understand the Federal project environment and what their responsibilities are, and how they shift and adapt according to new political imperatives.	This dimension addresses Research Question #4. In the NASA Substantive Model, the Required Capability of "Public Service Orientation" in the NASA Substantive Theory suggests that NASA public professionals can better execute FBC by possessing and developing a better understanding of Federal policies and procedures, thus potentially reducing policy incongruity in planning and executing FBC projects.
"Leadership of Mixed Public and Private Sector Teams"	This dimension builds on having to lead teams that rely on private sector resources and expertise. Leadership under these conditions requires effectively addressing the two very different philosophies of making money for the private sector and guarding the public interest in public service. Both environments require buy-in and demonstrated leadership capability and behavior, as well as a healthy attitude towards change and a personality that works well in a team setting.	The lack of an effective leadership model for FBC projects results in several interpretations on leading FBC projects for each Center and Enterprise. Political priorities may prevent development of Agency-level leaders, and these leaders may not be cognizant or committed to Agency goals and objectives, thus unable to achieve the necessary buy-in and insight or oversight capabilities for the program or project that they lead.	This dimension addresses Research Question #4. In the NASA Substantive Model, the Required Capability of "Leadership of Mixed Public & Private Sector Teams" reduces policy incongruity by ensuring more consistent leadership behavior and open communications between the contractors and NASA, with explicit outcomes defined between management and project personnel.

Axial Category Dimensions	Discussion of "Workforce Capability"	Impact on FBC	Application
"Acquisition Capability"	This dimension addresses the types of knowledges, skills, abilities, and attitudes that NASA public professionals need to acquire products and services from the optimal source (public, private, and academic) in terms of best value, Requirements definition and balancing risk emerge as key considerations in "Acquisition Capability."	NASA oversight organizations are promoting that smart risk should be encouraged and will help with the restrictions of a tight Federal budget. This is a key consideration in applying a successful acquisition strategy, and there is now a fundamental emphasis on achieving practical results. Because of this, acquisition capability is needed to emphasize low-cost and near-term gains to survive in the current budget environment, as well as leveraging private-sector partnerships.	This dimension addresses Research Question #4. In the NASA Substantive Model, the Required Capability of "Acquisition Capability" allows for flexibility in obtaining project resources and a better balance of risk between requirements and desires. It allows for the definition of explicit outcomes in the FBC Implementation Actions and supports risk management, innovation, smart choices, and outsourcing, thus reducing policy incongruity.
"Critical and Creative Thinking Skills"	This dimension can be viewed as convergent and divergent thinking. It results in more accurate representations and understanding of defining requirements and setting the boundaries for problems, situations, and opportunities. It also allows for the exercise of tools and techniques that promote innovative solutions.	Government historically has not been a place to be proactive or creative, but FBC cannot be implemented without the skills that result in explicit outcomes and innovative solutions. Sober discussions on balancing FBC requirements do not occur often enough within a structured framework, and innovative and proactive behavior is penalized.	This dimension addresses Research Question #4. In the NASA Substantive Model, "Critical and Creative Thinking Skills" allow NASA personnel to better define requirements and innovate for desired FBC outcomes. Better risk analysis, smarter choices, improved capability analysis, and better outsourcing result, reducing policy incongruity.

Axial Category Dimensions	Discussion of "Workforce Capability"	Impact on FBC	Application
"Technical Capability"	This addresses the expectation that NASA public professionals possess a high degree of technical knowledge and skills, enough to not only provide oversight, but to add value to the program or project by providing insight as a result of their knowledge and experience. This is closely related to the Leadership of Mixed Public/Private Sector Teams, simply because NASA cannot provide the cutting-edge technical expertise by itself.	In an FBC environment, NASA needs to leverage external resources so that its workforce maintains a sharp technology and engineering edge, especially if it wants to refocus itself into being a premier research organization. This is necessary simply because contractors will not respect NASA if the personnel do not perform at the minimum as peers in the technical discipline. In addition, oversight and insight are valuable and expected in an FBC environment, and NASA public professionals cannot safeguard the public interest without deep technical knowledge and experience.	This dimension addresses Research Question #4. In the NASA Substantive Model, "Technical Capability" gives NASA public professionals credibility and allows for effective management of outsourcing activities. It allows for NASA to provide insight for project activities as appropriate, and allows for smarter choices to be made based on a solid grounding in discipline-related areas where trade-offs need to occur. Policy incongruity is reduced through a better understanding of the true technical limitations of the FBC project.

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Experience

2001-Present **Intelligent Evolution, Inc.**, Alexandria, VA
Chief Operations Officer
Responsible for conduct and oversight of company operations in concert with the executive management team, to include:

- Business development with public and private sector organizations.
- Coordination with research and development activities.
- Assisting in development of corporate business plan.
- Ensuring corporate customers are receiving the best value in products and services.
- Assisting in maintenance of corporate strategic plan.
- Managing daily operations planning and metrics.

1997-Present **NASA Academy of Program/Project Leadership**
Performance Support and Technology, NASA Academy
Responsible for design, delivery, administration, evaluation of developmental programs for NASA Academy of Program/Project Leadership. Responsibilities include:

- Designing & implementing core PM competency programs for NASA Project Managers.
- Implementing Computer Based Training lesson modules.
- Creating a Project Management Assessment/Development Center & organizational metrics system.
- Implementing on-line help scripts, job-aids, knowledge tools.
- Developing online knowledge tools for Project Leaders.
- Performing as Facilitative Leader for automated & traditional group problem-solving sessions.
- Delivering videoconference & traditional training events for various skill sets.
- Created a joint engineering Master's in Systems Engineering program with NASA and MIT.
- Consulting with NASA on intact project team performance issues in project management..
- Developing case studies/research on performance issues.

1995-1997 **General Electric**, Rockville, MD

Pre-Sales Consultant, Electronic Commerce

Responsible for developing, managing, and delivering training & consulting programs to clients, internal employees, field sales/technical force. Programs included:

- Project Management, Group and Team Process facilitation.
- New Hire Sales Orientation & Corporate Values.
- Electronic Data Interchange & Electronic Commerce.
- Telecommunications, Internet, Intranet.
- Supply Chain Management, Marketing & Sales Strategy
- Pre-sales consulting, contributing $6 million in revenue.

1994-1995 **Graduate School, USDA**, Washington, DC

Supervisor, InfoShare Training

Implemented distance learning, reengineered products and processes for USDA InfoShare program. Automated field offices and increased service quality, conducted needs analyses, developed cost control budget system

Developed and implemented IRS program admin controls, directly resulting in cost/schedule control within six weeks.

1992-1994 **American Association of State Colleges/Universities**, Washington, DC

Training Program Manager

Responsible for program management of national automated higher education counseling & development program:

- Designed & developed all program, implementation, evaluation plans
- Fielded & supported program laptop computer systems
- Coordinated colleges, local/federal government offices, high schools
- Received several superior customer service letters/awards

1990-1991 **McDonnell-Douglas**, San Diego, CA (US Army Training-With-Industry)

Deputy Project Manager

Responsible for managing classified multi-million dollar weapons system program. Completed all deliverables within schedule/budget. Reduced manufacturing defect levels from 100 to 0 by applying Total Quality Management process. Received numerous Outstanding Customer Satisfaction awards.

1976-1991 **US Army**, Worldwide

Enlisted Soldier, Cadet, and Commissioned Officer (Major)

Commissioned through award of ROTC Scholarship. Duties included:

- College professor at Washington University, St. Louis.
- Line positions from Platoon Leader to Battery Commander.
- Staff positions from Executive Officer to Operations Officer.
- Designated as Primary Trainer for NATO Air Defense units.
- Leading 200 soldiers and managing $36 million combat arms unit.
- Enlisted Combat Medic & Operating Room Technician.

Education

1998-present **Virginia Tech**, Blacksburg, VA

Ph.D Human Development

1993-1998 **George Mason University**, Fairfax, VA

M.A. Industrial Organizational Psychology

1984-1987 **Boston University**, Boston, MA

M.Ed. Education Administration

1974-1976 **University of Southern Maine**, Portland/Gorham, ME

1978-1980 *B.A. Psychology*

Other Education, Skills and Certifications

- General Electric Facilitative Leadership Program.
- Army Training-With-Industry Program.
- GE Six-Sigma Quality Development Program.
- Industrial Experiments Course for Product Development.
- Certified Ventana Electronic Meeting System Team Leader/Instructor.
- Combined Arms and Services Staff College.
- Army Officer Advanced & Basic Officer Programs.
- Army Enlisted Basic Training & Combat Medic Course.
- Army Material Acquisition Management Program and Logistics.
- General Electric ISO 9000, ISO 14000, Six Sigma Quality Initiative.