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Shared Voyage

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Learning
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Dr. Alexander Laufer
Todd Post
Dr. Edward J. Hoffman
Foreword by Dr. Ronald A. Heifetz

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Shared Voyage is about four remarkable projects: the Advanced Composition Explorer (NASA), the Joint Air-to-Surface Standoff Missile (U.S. Air Force), the Pathfinder Solar-Powered Airplane (NASA), and the Advanced Medium Range Air-to-Air Missile (U.S. Air Force). Each project is presented as a case study comprised of stories collected from key members of the project teams.

The stories found in the book are included with the purpose of providing an effective learning source for project management, encouraging the unlearning of outdated project management concepts, and enhancing awareness of the contexts surrounding different projects.

Significantly different from project concepts found in most project management literature, *Shared Voyage* highlights concepts like a will to win, a results-oriented focus, and collaboration through trust. All four project teams researched in this study applied similar concepts; however, they applied them differently, tailoring them to fit the context of their own particular projects. It is clear that the “one best way” approach—which is still the prevailing paradigm in project management literature—should be replaced by a new paradigm: Even though general project management principles exist, their successful application depends on the specifics of the situation.

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FOREWORD

by Dr. Ronald A. Heifetz
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The quality and abundance of leadership markedly impacts the project world. Yet in our research literature we still tend to treat projects primarily as technical efforts that require management, i.e., the authoritative organizing of systems with an emphasis on planning and control. In our prevailing paradigm, the essence of project management consists of performing with minimal changes, according to plan.

Along come Laufer, Post, and Hoffman to shake loose that paradigm in the most compelling way—through four stories brilliantly organized and told first-hand. Their book, *Shared Voyage*, opens our eyes freshly to the realities that accompany projects that push the envelope by showing vividly and tangibly what it takes to succeed in a dynamic environment characterized by high uncertainty and frequent unavoidable changes.

People need first-rate management when they face known challenges that fit their organizational designs, norms, and expertise. But they need leadership to tackle new challenges for which adaptability becomes paramount. In fact, projects usually present a bundled set of challenges demanding that people operate in both known and new domains at the same time. The known domains are amenable to technical expertise and managerial authority, but the new challenges, which we term adaptive challenges in my 1994 book, *Leadership Without Easy Answers*, require leadership that can handle the conflict and messiness of ongoing structural tensions across different organizations and groups as they strive for collective innovation.

Each of the four cases in this book illustrates leadership. Leadership, as our team at Harvard has defined it, is the activity of mobilizing people to meet adaptive challenges, which consist of gaps between aspirations and current reality that demand responses outside our repertoire. Such is the stuff of these extraordinary

stories: building a satellite that can study particles from gas clouds outside the solar system, procuring a cruise missile with revolutionary capabilities at an “impossibly” low cost, designing an unmanned airplane that can fly on solar power at nearly 100,000 feet, and quickly building a new supersonic air-to-air missile by introducing a new acquisition system that dramatically changes the traditional relationship between government and contractors.

Leadership in these stories is not restricted to people in positions of authority. We see that the adaptability of an enterprise requires that many people exercise leadership at various moments in a complex process, within and across organizational lines. Indeed, we learn from these stories how anyone with the courage and skill to mobilize the relevant people on a project—to face new data, tough questions, or internal contradictions among value priorities—exercises leadership, and that such initiative may come from just about anywhere, high and low, at different moments in time.

This is what we see in *Shared Voyage*: leadership by the project’s key people, each of whom operates from a different position of authority—from the project manager across to the contracting managers and on down amongst their talented crews of financial, legal, and engineering experts and personnel within each organization. What unleashes and organizes these disparate activities? Quite extraordinary project leadership from those in authority who have learned when and how to deploy themselves and their power to build trust across organizations and develop in people a sense of mission and a willingness to experiment, take risks, and cut losses.

This book not only dares to establish the crucial and immediate need to move from project management to project leadership; it also goes a long way in guiding the reader to start this difficult transformation. Like all paradigm changes that call for learning new principles and practices, the change first starts with the more difficult phase of unlearning old beliefs and obsolete tools. The many stories presented in this book, in the words of the central players themselves, convey information in a wonderfully entertaining way and help considerably in seeing the reality of leadership anew. Although perhaps hard to imagine for a book on project leadership, this book is a page-turner, with stories that enable the reader to experience vicariously the frustrations of unexpected changes and the satisfaction of overcoming them.

The stories illustrate several key principles. First, adaptive leadership is both active and reflective. In daring new ventures involving unpredictable realities, you have to constantly alternate between participating and observing; you must be part of the action and yet also rise above it to analyze more clearly changing landscapes requiring ongoing corrective action. To use a metaphor, you have to be able to “get off the dance floor and get on the balcony.” The four case studies in *Shared Voyage* demonstrate how skilled individuals were able to tailor their management approach to the constraints and opportunities provided by the unique context of those projects. They show how leadership involves improvisation, learning as you

go, conducting reflective conversations with unfolding situations during each stage of the project, and asking basic questions over and over again, like, What are we trying to do here? and, What can we learn from what just happened? As payload manager Allan Frandsen puts it, “Following the rules is fine, but you have to know when the rules need to be bent, tailored, or even broken.”

Adaptive processes in evolutionary biology are experimental—sex rather than cloning, designed slack in the recombination of DNA that generates mutations. The keys to success in a changing environment posing new adaptive pressures lie in running multiple genetic experiments continuously, with most of them failing. Rather than investing the knowledge in high authority, which makes sense for technical problems, adaptation is more likely to succeed with a distributed intelligence. So too in cultural, organizational, or political change, adaptive work requires experimentation. You never can know from where the new idea, or critical insight, may emerge. As U.S. Air Force Program Director Judy Stokley put it, “Look and listen, because it may surprise you who emerges as your change agents. No one looking from the outside would have picked the ones that were mine... some were introverts, people with unglamorous jobs. They emerged mostly on their own, and they possessed tremendous personal courage. I simply gave them an opportunity to contribute, and they came back with some of the most creative ideas.”

Thus, the managerial mindset for new efforts like these projects needs to be experimental. Budgets, contracting relationships, debriefing procedures, supervision of the work itself, all must have the adaptability to respond to new information, even disappointing data, like the disintegration of the high flying solar bird. Ray Morgan, vice-president for AeroVironment, which designed and built the plane, reflected on the apparent catastrophe, “An unexpected benefit of the accident was that we learned a tremendous amount about our plane. . . . Had we not been as successful a team as we were at that point by focusing on continuous learning and improvement of procedures, we would not have recovered.” But as you will see, learning how to learn from failure—particularly tough, scarring failure—is not easy. Ray Morgan and others here show us how, and in doing so demonstrate what it means to move from authoritative management to authoritative leadership.

Second, adaptive work generates tough trade-offs between legitimately competing claims, or as Dr. Edward Stone, the Principal Investigator on the satellite project described it, “the difference between ‘desirements’ and requirements.” But discovering which trade-offs to make requires drawing out divergent perspectives, orchestrating conflicting views and interests, and listening for the crystallization of a good idea rather than reaching too quickly for decision. Orchestrating creativity and conflict is messy, takes patience, and requires holding people’s feet to the fire, be they members of a project team or contractors who run over budget. Moreover, trade-offs are painful. Jobs are lost, people are let go. Casualties are often necessary. You have to have the stomach to deliver bad news, and the heart to deliver it well.

Third, leadership is a political activity, even in projects. You have to know, or find out, and then work with the stakes of those whose commitments you need in order for the project to succeed. When people make the classic leadership error of treating adaptive challenges like technical problems, they end up assuming too much about the relevant stakeholders and then step on toes unwittingly. They find themselves being surprised when their “exciting initiative” generates resistance to the losses that accompany change, and often they make this discovery too late in the game, when their efforts have already been neutralized. As John Thurber at NASA put it: “The lesson here is pretty clear: everybody has a piece of the turf, and you’d best respect that. You never know how much your lack of respect may cost you.” Or as Jenny Baer-Riedhart, program manager at NASA describes, “Early on in this endeavor, I learned a key lesson in working with multiple customers: always know the folks you’re meeting with, and always tailor what you’re going to say based on who you know will be there. . . . Politics doesn’t have to be a dirty word if it means working closely and openly with customers and stakeholders.” To move from A to B, you have to know where A is, and start there.

Fourth, leadership is about challenging people to take far-reaching responsibility. The task is to put the creative work back in people’s laps when parochial views inhibit new thinking and necessary collaboration. This cuts against the grain of authoritative and managerial expertise, in which most of us are trained to take problems off people’s laps and deliver back solutions. With technical problems, this mode of operating works efficiently and well. But with adaptive challenges, it does not. Adaptive leadership requires the courage to say to your people: “I don’t know how you’re going to figure this out, but I have confidence that you will, and if you don’t, we all fail.”

Terry Little, project manager at the U.S. Air Force, put it this way when embarking on an effort to revolutionize procurement, “What I wanted to do was set something that would challenge these folks to look at things in an entirely new way. I didn’t want a schedule that they felt they could achieve just by working on weekends or figuring out a handful of inventive ways to do things. I wanted something so outrageous that it would cause them, first, to essentially give up, but then—once they figured out that giving up wasn’t an option—to step back and examine all their assumptions, all their beliefs, all the things that were in their heads as a result of their experiences and what they had been told in the past, and to ask themselves with a clean slate, What do I really need to do to achieve this goal?”

Placing and developing a greater sense of responsibility takes structures of accountability. It also takes endless communication working with people because, with an adaptive challenge, the people with the problem are the problem, and they are also the solution. If they do not change their ways, nothing really changes. Unlike technical problems that can be abstracted from people’s values and habits, adaptive challenges cannot be taken off people’s laps. As in medicine, with the adaptive part of the work, you cannot put the patient to sleep, do the surgery, and imagine that you’ve fixed the whole problem; after surgery is completed the heart patient

has to change his way of life, and the medical team has to guide the patient through the process of facing up to his responsibility for his own health.

Judy Stokley, in preparing to draw down the government workforce and change the basic nature of its relationship with contractors, gave this a name: “‘Task Destination’ was the name I came up with for this activity. I put together a small team, and together we asked, What is it that needs to be done? And then we asked, Okay, who ought to do it? Is that inherently a government function, or is that something that ought to be done by the contractor?”

Ray Morgan put it this way, “Our first rule was always to ‘put the person closest to the problem closest to the solution.’” Of course, this can generate parochialism. People need to see across the boundaries of their jobs, too. Morgan adds, “It is essential that the person responsible have available the information necessary to understand impact on other systems from their work. A good work breakdown structure and good communication were essential.”

Fifth, adaptive work takes time. Judy Stokley completed her Task Destination within days; the analysis was the technical part of the problem-solving. The implementation, on the other hand, took six months because implementation consists of changing people’s hearts, minds, and habits of behavior. People will either sustain the direct loss of their own job, the indirect loss associated with a friend or colleague losing their job, or the loss of competence for a period of time during which they must learn new competencies. Closer to where the tire hits the road, implementation is more than execution, it demands of people that they face some losses and learn new ways. That takes time. People don’t learn that fast. It would be terrific if projects could be “efficient,” but innovative adaptations take time to make happen.

Finally, leadership infuses the work with meaning. People are willing to take risks, and even pay dearly, if the stakes are sufficiently meaningful. Money is only part of it. Each of these projects had a mission oriented by values that spoke to people. But all too often we lose touch with the meaning of our work. One of the key tasks in mobilizing adaptive work, therefore, is to embody and remind people, perhaps to the point of our own boredom, of the overarching purpose for which they are taking pains. Again, here’s Judy Stokley on profoundly changing the government’s relationship with contractors: “I wanted very much to change that mindset, and get the contractors to have . . . a ‘heart and soul’ relationship with their products.” In the end, her contractors got the message. Chuck Anderson from Raytheon put it this way: “It’s that big vision and our commitment to deliver a superb weapon that our nation’s war fighters can rely on. That’s the common vision. Judy embraced it with all her heart, and I embraced it too. Our jobs were to make certain that the people who worked with us shared our commitment.”

I believe that this book will prove to be a major contribution to the fast growing project management community. The messages, only a few of which I’ve tried to capture here, come through clearly. Moreover, I hope this book stimulates other researchers to begin with the raw data of case stories, and move from there to the abstracting of leadership principles.

Shared Voyage: Learning and Unlearning from Remarkable Projects

Shared Voyage clearly demonstrates that leadership was shared by many in each of the four cases. Interestingly, leadership was also shared among the authors doing the research for this book. By using stories to construct a fuller picture of reality, they sought to go where few project researchers have gone before. And they did it brilliantly. *Shared Voyage* sets a higher standard for both the practitioners and researchers of projects.

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Chapter One

INTRODUCTION: CASE STUDIES THROUGH STORIES



This book is about four remarkable projects, two from NASA and two from the U.S. Air Force, and each is presented as a case study comprised of stories collected from key members of the project teams. We chose this format for *Shared Voyage* because people, to put it simply, love to read stories. Stories attract and captivate, plus they are memorable.¹ The fact that most people are attracted to stories is crucial, especially in situations where the prospective learner suffers from a lack of time—which is the case for most project managers. More important, stories are very useful for sharing and disseminating organizational knowledge.

Story-based management books are not a new phenomenon. *In Search of Excellence* is probably the best known story-based book on general management,² while *The Soul of a New Machine* is probably the best story book ever written on managing a project.³ Our book, *Shared Voyage*, is meant primarily to serve as a self-learning handbook and reference guide for experienced, as well as less experienced practitioners. It should be useful for the entire project community: project managers, team members, managers to whom project managers report, and project customers and users. The story format makes it user-friendly for all those project managers and team members working in industry, business, and government, in the United States and throughout the world. Students, researchers, and scholars of project management and public administration should find it useful as well.

Shared Voyage was based on four assumptions:

1. Throughout the past two decades, the world has become a more dynamic place, characterized by a volatile, fast-paced economy, rapid rates of change, global competition, and a transition from a producer-dominated market to a customer-driven market.⁴
2. In such a world, the concepts and tools for managing projects must change to keep pace. While individual researchers have addressed this issue for more

than a decade, only recently has it received wide attention by the project management research community.⁵

3. In just this last decade, we have gained a far better understanding of how new management knowledge is created and shared.⁶
4. And in the last decade, we have also gained new insight into the role of practitioners in generating and also applying new management knowledge. We have also gained better understanding regarding the important role that published research in management can play in enriching the relationship between practitioners and researchers.⁷

The first two assumptions served as the triggers for the book, while the last two have shaped its objectives and served as guidelines for the methodology and format.

Shared Voyage has three major objectives:

1. To provide an effective learning source for project management.
2. To encourage unlearning outdated concepts of project management.
3. To enhance awareness of the different contexts surrounding projects.

In the following sections of this introduction, we will elaborate on these three objectives, and then describe their implementation. Afterwards, we will discuss the rewarding relationship that may exist between practitioners and researchers.

First Objective: Provide an effective source of learning about project management

Knowledge may be compared to a spectrum. At one extreme, it is almost completely tacit—semiconscious and unconscious knowledge stored in the minds of individuals. At the other end of the spectrum, knowledge is almost completely explicit and structured, and accessible to people other than the individuals originating it. Most knowledge, of course, exists between the two extremes.⁸

The importance of local and tacit knowledge in engineering work in particular is underscored by Diane Vaughan in her comprehensive study of the Challenger accident. Vaughan calls our attention to the fact that, “the public is deceived by the myth that the production of scientific and technological knowledge is precise, objective, and rule-following.” The myth grows, in part, as a result of the formal language and specialized skills employed in the production of technology. However, when technical systems fail, outside investigators consistently find that the engineering work was characterized by ambiguity and ad hoc rule making. In the engineering world, Vaughan stresses, “practices do not follow rules; rather, rules follow evolving practices.” Vaughan concludes that in the engineering world, local knowledge and tacit understanding, based on learning from experience, is indeed central, and “experience becomes the quintessential learning device.”⁹

Project management lies somewhere between a “technology” and a “craft,” though probably closer to a craft. It is not like that of laboratory technicians or

bookkeepers, who have highly structured practices and procedures which can be completely described and taught with the aid of formal rules. It is also not exactly like skilled trades, which are acquired mainly through demonstration and apprenticeship, such as musicians and bricklayers. While some aspects of project management knowledge are explicit, a great deal of it, especially in a dynamic, complex, and fast-changing environment, is tacit.

Based on a variety of sources regarding ways for capturing tacit knowledge, there is ample evidence to support the view that “a good story is often the best way to convey meaningful (tacit) knowledge.”¹⁰ Because this is an era in which practitioners are constantly bombarded with endless numbers of problems, surrounded by an overabundance of information of which only part is relevant and can be used—and it is extremely difficult to find the time and motivation to acquire new knowledge—only those means of learning that can successfully compete for practitioners’ sorely limited free time will actually get their attention.

K. E. Weick and L. D. Browning, who analyze the use of argumentation and narration in organizational communication, suggest that, “Narration, much like metaphor, has power precisely because it captures complex experiences that combine sense, reason, emotion, and imagination. Narration blends all those elements together and preserves their interaction in a compact summary.”¹¹ In discussing what is needed for sense-making (which is essentially what knowledge does), Weick says, “The answer is . . . something that preserves plausibility and coherence, something that is reasonable and memorable, something that embodies past experience and expectations, something that resonates with other people, something that can be constructed retrospectively but also can be used prospectively, something that captures both feeling and thought, something that allows for embellishment to fit current oddities, something that is fun to construct. In short, what is necessary in sense-making is a good story.”¹²

Second Objective: Encourage unlearning of outdated concepts about project management

In recent years, more and more business leaders have realized that knowledge is the chief asset of organizations and the key to maintaining a sustainable and competitive advantage.¹³ Organizational learning, or learning within the organization, means the continuous acquisition and testing of experience and the transformation of that experience into knowledge that is made accessible to everyone within the organization.

“Creating a ‘learning organization’ is only half the solution,” assert G. Hamel and C. K. Prahalad. They recommend, that in addition to the familiar “learning curve,” companies should establish a “forgetting curve,” which is the rate at which a company can unlearn those habits that hinder future success. They stress, however, that pursuing unlearning is not easy. First, unlearning is more difficult than learning, and, second, the real difficulty is how to be selective, that is, to decide what part of the past should be forgotten and what must not.¹⁴ March et. al. also reported that

organizations do not easily abandon previously believed theories, and in general, learning from history is conservative, and tends to sustain existing beliefs.¹⁵

Peter Drucker opens his book *Management Challenges for the 21st Century* with the question: Why do assumptions matter?¹⁶ He replies that basic assumptions about reality are the paradigms of management. They are usually held subconsciously by the scholars, the writers, the teachers, and the practitioners. Yet, Drucker explains, “Those assumptions largely determine what the discipline—scholars, writers, teachers, practitioners—assume to be reality.”

Peter Senge raises a related question: Why are mental models so powerful in affecting what we do? He suggests that, in part, it is because they affect what we see. Senge explains, “Two people with different mental models can observe the same event and describe it differently, because they have looked at different details.... They observed selectively.”¹⁷

In recent years, project management literature has provided many examples of the need for unlearning.¹⁸ For example, managers have traditionally treated prototyping as a technical tool to be used by engineers responsible for the progress of technical activities. Today, according to S. C. Wheelwright and K. B. Clark, prototyping should be treated as “a key management tool for guiding development projects.... Senior managers, functional heads, and project leaders who do not understand and fully utilize the power of prototyping unintentionally handicap their efforts to achieve rapid, effective, and productive development results.”¹⁹

R. Nisbett and L. Ross conclude that people tend to persevere in their beliefs well beyond the point at which logical and empirical considerations can sustain them.¹⁹ They do not have a conclusive answer to the crucial question—When and why do beliefs yield to evidence? (or, When and why people are willing to change their mindset and unlearn the past?) However, they indicate that people will tend to change a mindset if it is based on more vivid information. They explain that information is considered vivid when it is emotionally interesting, concrete and imagery-provoking, and proximate in a sensory, temporal, and spatial way²⁰

Good stories, told by successful and credible managers, usually convey vivid information, and thus may facilitate changing a mindset.²¹ Moreover, the attraction of stories and their non-threatening nature ensure that people will be willing to read multiple stories that advocate the same kind of unlearning, thus enhancing the chances that stories will indeed facilitate unlearning.²²

Organizations have long found stories useful for a variety of purposes, such as introducing change and fostering organizational identity and values.²³ In recent years many leading organizations have started using stories to capture and disseminate knowledge.²⁴ 3M, for instance, has found the standard bullet outline format used in strategic planning to be too generic, too simplistic, too implicit in its assumptions, and flat-out uninspiring. “Strategic narratives,” on the other hand, were found to clarify thinking, capture the imagination, and excite and energize people. The same reasons that motivate 3M to use stories to communicate strategic plans can apply to the transfer of knowledge in any organization.²⁵

Third Objective: Enhance awareness of the impact of context on projects

Peter Drucker argues that, since the study of management first began in the 1930s²⁶, several assumptions regarding the realities of management have been held by most scholars, writers and practitioners. He further argues that today these assumptions must be unlearned. Two of these assumptions are germane to our study:

1. There is (or there must be) ONE right organization structure.
2. There is (or there must be) ONE right way to manage people.

Regarding the first assumption, Drucker recommends that much work must be done in organization theory and practice to help managers develop “the organization that fits the task.” As for the second assumption, Drucker argues that, “In no other area are the basic traditional assumptions held as firmly—though mostly subconsciously—as in respect to people and their management.” More importantly, “In no other area are they so totally at odds with reality and so totally counterproductive.” We completely agree with Drucker’s assessment, which is why we treat this specific unlearning issue as a separate objective for the project.

The “one best way”²⁷ approach, which was the favorite phrase of Fredrick Taylor, the father of “scientific management,” came under sharp attack by Henry Mintzberg as well. In *The Rise and Fall of Strategic Planning*, Mintzberg discusses forms of organizations, and says: “Throughout this book, we have repeatedly criticized the “one best way” thinking in the management literature.” He goes on to explain that organizations differ just like animals, and it makes no more sense to prescribe one kind of solution to all organizations than it does to describe one type of housing for all mammals.²⁸

The scientific management “one best way” approach, and the general philosophy from which it is derived, are seen by I. Nonaka and H. Takeuchi as hindering knowledge creation.²⁹ Nonaka and Takeuchi explain that to increase production efficiency, Taylor, the founder of scientific management, tried to replace “rules of thumb” with science. He attempted to transform workers’ experiences and tacit skills into objective and scientific knowledge. However, he failed to see that these experiences were actually a rich source of new knowledge. Nonaka and Takeuchi concluded that scientific management treated human beings as stimulus-response machines having limited capability to create knowledge.

Elaborating on the assumptions behind the case method as a teaching methodology, a publication by the Harvard Business School (HBS) says: “There is general business knowledge...There are many general principles...Even though general knowledge exists, its successful application depends on the specifics of the situation.”³⁰

However, in a recent article, G. Johns presents convincing evidence that organizational researchers downplay “the specifics of the situation,” or as it is often termed, “the context.” According to Johns, it seems that context-free research is somehow perceived as being more scientific and prestigious than context-specific research. Johns also gives examples of attributes that may define the context in organizational

research, such as, informational attributes (e.g. ambiguity), task attributes (e.g. autonomy), physical attributes (e.g. danger), and social attributes (e.g. norms).³¹

For the most part, the project management literature also did not give explicit treatment to context issues, with some notable exceptions regarding software projects. For example, J. A. Highsmith states: “There is no silver bullet, but there are Lone Rangers who have arsenals of bullets for different situations.”³²

In 1998, NASA took a bold step in its official approach to managing projects, switching from “Taylorism” to “Tailoring.”³³ The switch came as a result of a study done by a courageous group of project managers who studied project practices in successful projects within and outside NASA.³⁴ They found that, “Success was not achieved by omitting steps in the Life Cycle Development process, but by innovatively tailoring the process to fit the constraints of the specific project.”³⁵ However, based on our work with many of the best project managers in NASA, it is our strong impression that like any other fundamental unlearning, embracing this change in the field is a very slow process.³⁶

Stories can play a very crucial role in facilitating the required shift from Taylorism to tailoring, from context-free approaches to context-specific ones. Researchers, comparing a “one best way” type approach to a story-based approach, reached similar conclusions regarding context. H. Zukier, for example, compared paradigmatic and narrative modes in goal-guided inference, and found that the narrative mode is highly context-sensitive.³⁷

T. Numagami suggests that the objective of management studies should be changed from a search for invariant laws of practical use to the encouragement of a reflective dialogue between researchers and practitioners and among practitioners. He also suggests that the case study is an excellent vehicle for such a dialogue.³⁸ H. Tsoukas also asserts that management studies should focus on reflective action rather than searching for invariant laws, while M. N. Zald contends that the mission of the “scholar-practitioner” is to cultivate the reflective capacity of “the citizen-customer.”³⁹ Numagami argues that the case study can cultivate the practitioners’ thinking process and amplify a potential variety in their thinking to the point that they will be able to cope better with the complexity they will face in the real world. A well-written case study, he contends, would encourage the reader to start the thinking process as follows: If I were him or her, I would do that, and/or, If I were the manager’s subordinate, I would like him or her to do otherwise.⁴⁰

The unique design of *Shared Voyage* can enhance awareness of the importance of project context, and induce more reflection on how context should affect the application of management principles.⁴¹ An example from the four cases in the book may demonstrate this. We shall focus on trust-based teamwork. All four projects adhered to this principle, but they differed in the way they applied it, in its final shape, and in its relative importance to their success. The following is a brief, simplified analysis of the variety of context factors surrounding each project, and the way the project chose to fit the principle to these context factors.⁴²

Pathfinder Solar-Powered Airplane (NASA)

Primary focus of project: testing and refining a new technology

A small group of people, not fully supported by some of their parent organizations and affiliated with a temporary novel organizational arrangement (industry alliance), are co-located away from their permanent base. They are able to form, almost naturally, an extremely cohesive, powerful, and remarkably badgeless, trust-based team.

Advanced Medium Range Air-to-Air Missile (U.S. Air Force)

Primary focus of project: organizational change

Two very large organizations in a crisis situation, where they are on the verge of becoming extinct, take explicit measures to develop and sustain an exemplary, large, long-term, trust-based team committed to a clear purpose. This unique cooperation is probably the hallmark of their performance and the foundation for their future success.

Joint Air-to-Surface Standoff Missile (U.S. Air Force)

Primary focus of project: developing a new product

Large organizations, under acute time pressure, as well as a few other constraints, take several explicit steps to ensure success. One of them is the development of time-bound, co-located, small, trust-based teams.

Advanced Composition Explorer (NASA)

Primary focus of project: conducting science

Three large organizations, widely dispersed geographically and culturally, are faced with the development of a complex product, within a fixed timetable and under a novel arrangement of the co-leadership of a project manager and a principal investigator. Without reducing the cultural differences, trust-based cooperation has not culminated in the development of one cohesive team. Rather, various groups and individuals develop different mechanisms, with varying degrees of cooperation, depending primarily upon the constraints imposed by the “cultural distance” between the organizations.

The major lesson we took away from the study was that all four cases enjoyed very skilled leaders who were able to tailor their management approach to the constraints and opportunities provided by their unique project context.

IMPLEMENTATION OF THE CASE STUDIES THROUGH STORIES PROJECT

In our previous research, we have accumulated many stand-alone stories, each told by one practitioner who focused on a particular episode in the life of his/her project.⁴³ However, we did not have experience collecting multiple stories that cover the entire project from a group of practitioners involved in that project. Though the idea of interviewing the entire project team seems so logical and simple, we could not find any precedent for this kind of study in the literature

and thus suffered from the drawbacks of being pioneers. We therefore relied heavily on sources from three major, somewhat related, research fields: case studies,⁴⁴ oral history research,⁴⁵ and narrative inquiry.⁴⁶

To better understand how this current study was conceived, it would be most important to review some of the activities that engaged the co-authors prior to its inception. In 1994, Alex produced his first book of project stories that he co-authored with three Procter & Gamble (P&G) project managers. That book comprised 70 stories told by 28 P&G project managers.⁴⁷ In 1998, Alex began his collaboration with Ed in the development of several knowledge-sharing projects. Their first project was based on 70 project stories they collected from 36 federal government project managers. Their book, *Project Management Success Stories*, was published in 2000.⁴⁸

In the summer of 1999, Alex and Ed led the first Forum for Master Project Managers, where thirty carefully selected NASA project managers met for two days to share their knowledge by presenting and discussing their own project stories. During the years 2000 and 2001, Alex and Ed explored several ideas for additional knowledge-sharing forums, first at individual NASA Centers, and then at central locations where several Centers met together every three months for a one-day session. Since 2002, the Forum of Master Project Managers, composed of about 40 of the best project managers from NASA, and an additional 10 very experienced project managers from other federal agencies and the private sector, has become the primary venue for sharing and discussing new project management knowledge at NASA. Participants of the Forum are selected very carefully by their colleagues through an elaborate system of referrals. The Forum meets twice a year, in February and in August, for two-day sessions, and its presentations and discussions are published in *ASK* magazine (Academy Sharing Knowledge).⁴⁹ *ASK* magazine, which was also conceived by Alex and Ed, was established in the fall of 2000 when Todd joined the team and became *ASK*'s editor (while Alex assumed the role of editor-in-chief and Ed served as publisher). The first issue of *ASK* magazine was published in January 2001.

In late 2000, Alex came up with the idea to develop and share project knowledge via case studies, each to be composed of multiple stories, as a natural evolution of time-old learning through stories. He also developed the primary characteristics of the cases, (e.g., each would be composed of about 30–40 stories which were told by 5–10 key project participants).

SELECTING THE PROJECTS

To fulfill the first objective of the study, “to provide an effective learning source,” we chose to study successful projects. In sharing their research methodology for *Organizing Genius*, W. Bennis and P. W. Biederman explain why they chose to focus exclusively on “great groups,” when the majority of working groups we typically encounter in our daily life are not so. “The reason is our conviction that excellence is a better teacher than mediocrity.” They further assert

that the lessons of the ordinary are everywhere. However, “Truly profound and original insights are to be found only in studying the exemplary.”⁵⁰ R. H. Waterman, in the opening of his book *What America Does Right*, provides a similar rationale for his work, saying: “The theme is similar to that of everything I’ve written, starting with *In Search of Excellence*: learn from the best; find role models and emulate.”⁵¹

Selecting successful projects was even more crucial for fulfilling the second objective of the study, “to induce unlearning.” Earlier, we presented a brief explanation regarding the difficulties we all have in unlearning the past. It is clear that asking people to change a mindset is easier said than done. We therefore believe that if we can engage a person’s attention by sharing interesting stories, and if we can ensure the perceived credibility of the sources by selecting successful projects, we can enhance the ability to unlearn.⁵²

The selection of suitable project managers and projects, probably the most crucial issue for the success of this kind of project, was actually accomplished rather easily. Based on their work on *Project Management Success Stories* and with the Forum, Alex and Ed were exposed to a large number of suitable projects and project managers. They approached Don Margolies (NASA project manager of ACE), Terry Little (USAF program director of JASSM), and Jody Stokley (USAF program director of AMRAAM), and obtained their agreement to actively participate in the case studies project. These three very seasoned project managers, who were highly regarded by the Forum’s participants, had shared several of their stories in *Project Management Success Stories*. Alex and Ed then took on a fourth project leader, Ray Morgan (Vice President at AeroVironment, who together with Jenny Baer-Riedhart from NASA had led the development of Pathfinder), who was not a participant of the Forum at the time, but was highly recommended by its members.

The Forums included other very successful project managers who could have become viable candidates for the case studies project. These four specific individuals, however, were selected not only because of their proven records throughout their careers and the specific project selected for the study, but also on the basis of the nature of the projects themselves. The third objective of the study, “to enhance awareness to the different contexts surrounding different projects,” called for the selection of dissimilar projects. We were therefore looking for projects that differed in their primary task (e.g., conducting science, developing a new product), in their major drivers (e.g., speed, sustained existence), and projects that also differed with regard to other factors such as size, dispersion of key players, and stakeholder support. The selected projects provided an exposure to four very dissimilar projects.

The unique features of the various projects were primarily studied via formal government publications, papers and Internet reports (many of these sources also provided useful material that augmented the interviews and are presented throughout this book).

The selected projects were required to fulfill one more criterion—they had to have been executed during the last decade. Obviously “old” projects fade in collective memories, but our main concern had more to do with our ability to find and obtain interviews from the key people who were still active (indeed, following the interview phase of the study, at least four key people went into retirement). It is important to note that studying very recent projects is not always an asset. In science and development projects (and especially when one studies only one phase of a project), success very often includes a few criteria that can only be fully appreciated some time after project completion, when all the elements can be seen in total perspective. This was the case, for example, with JASSM. We therefore selected recent projects, but not too recent: two of the projects (or the phases that we studied) were completed in 1997, and two in 1998.

Alex and Todd selected the other participants in the study (the additional interviewees) following intense consultation with the four leaders of the projects. While most of the interviewees were selected during the design phase of the case studies project, a few were recruited later, during data gathering, when the need for their unique points of view became evident.

Prior to the interviews, we attempted to familiarize ourselves with each of the four projects and their contexts by acquiring any written descriptive material we could find (published reports, printed or electronic, newspaper articles, as well as written material supplied to us directly by the participants).

CONDUCTING THE INTERVIEWS

We selected the participants according to the unique perspective they could contribute to the study, primarily as a result of their role or organizational affiliation. The number of people interviewed per project ranged from 5–11. (A brief biographical description of the interviewees is presented in appendix A.) For each project, at least one member from the contractor organization was interviewed: the contractor’s project manager.

To facilitate a reflective dialogue and improve the recall of the storytellers, we attempted to interview the participants in groups.⁵³ Having people representing different organizations and participating in the same interview enhanced the chances that the dialogue would enable us to collect information representing multiple perspectives. Since all participants were very busy practitioners, it was difficult to arrange for them to meet in groups, and preferably diverse groups. This slowed the pace of meetings, and extended the duration of the study to almost two years. Still, more than a few interviews were conducted with just one storyteller. (See a detailed schedule of interviews in appendix B.) All interviews were taped and later transcribed.

We were also surprised to find that interviewing the participants in groups may have been less productive than we had thought. We originally believed it would improve the quality of the data because, when necessary, one would fill in the memory gaps of the others. We also believed that it would encourage people with

different perspectives to engage in a productive dialogue that would yield a richer understanding and presentation. While group interviews very often resulted in improved and enriched data, it was not free of deficiencies. In particular, in cases where we the interviewers, prior to the interview, lacked an overall understanding of the subject at hand, the progress and the productivity of the interview usually suffered considerably. We concluded that if there were not sufficient published material that could be reviewed prior to the interview, it would probably be preferable to start by interviewing individuals (as we did in JASSM), rather than a group (as we did in the rest of the cases).

We first believed that it would be highly desirable to have two interviewers, especially when meeting with a group. Therefore, at the beginning, Alex and Todd conducted all the interviews. We later found that it was a key factor limiting our progress (that is, it was very difficult to find an acceptable time convenient for the group of participants, as well as for Alex and Todd). More importantly, we found that while it was helpful for each of the co-authors to have a first hand opportunity to meet with the storytellers, and to observe them interacting with each other, the quality of the interview per se had not been markedly improved. Therefore, in the latter phases of the study, Todd conducted many interviews alone.

The last surprise relating to the process had to do with the number of people interviewed per case study, and the number of hours devoted to each interview. We found that one should not conclude that the “larger the number” the better the quality of the data gathered. We believe that a more appropriate conclusion is that the larger and more dispersed the organization, and the greater the number of different organizations participating in project, the more participants and interview hours are required. We therefore believe that the number of hours devoted to the different projects primarily reflect their organizational complexity.

Numagami asserts that since the purpose of the interview is to articulate tacit knowledge, “The touchstone of a good interview is not whether it is replicable, but whether it is an opportunity for discovery both for the interviewer and the interviewee.”⁵⁴ Indeed, we took pains to foster a true learning environment. The participants were strongly encouraged to share success as well as failure stories, and to air their disagreements regarding facts (that were easily resolved following the interview). But more importantly, they shared differing views regarding interpretation of the facts, tangible (e.g., results), as well as less tangible (e.g., intentions). These different perspectives, as well as the failure stories, were later incorporated into the case studies.⁵⁵

During a typical interview we asked participants to recount major events and developments in the life of the project, and share stories that could shed light on these events. Our participation in the dialogue usually entailed two roles: guiding and questioning. We tried to guide the participants through the early phases of the project and continue through completion. Throughout the interview we asked many questions, primarily to clarify the information. For example, how does the specific story relate to another story we heard before, what was done

prior to a specific action, why was another seemingly obvious action not taken, what were the feelings of certain people prior or following a certain episode, whether it was difficult to make a specific decision, etc. Participants were promised that they would be given the opportunity to review and edit the entire manuscript, and this helped the conversation to be open. For example, there was hardly an occasion in which a participant felt a need to say: “This is not for the record; please turn off the tape recorder.”⁵⁶

Following our first interview for this study, in March 2001, we approached the interview phase of the project with some apprehension. We were worried that we would have to intervene often and “guide” the interviewees to glean the useful data. However, we were surprised to find that very often this was not the case. Apparently, two factors helped us. First, most participants knew what to expect during the interview. We believe that the material sent to them (*Project Management Success Stories* and recent issues of *ASK* magazine) were very helpful. Second, and probably more important, was the fact that they all came highly motivated, focused, and enthusiastic to share their project experiences. It was clear that they had already selected the project episodes that they wanted to share prior to the interview.

At the data collection phase we had to contend with a clear dilemma. We naturally wanted to gain deeper understanding by covering the project comprehensively and by acquiring rich information. However, we had to cope with the limited time of the busy storytellers, and had to consider the limited time of another community of busy practitioners—the prospective readers of this book. Since we decided not to sacrifice the depth of the study, we wanted to contain the overall scope and focus, that is, to focus only on the major phases of the project, and only on the primary organizations participating in the project.

COMPOSING THE CASES

The third phase of the project, comprising the cases, was not only the most demanding phase time-wise (we estimate that, together, the three of us invested more than 4,500 hours in this phase), it was also very demanding mentally and emotionally.

Throughout the years we have learned that effective story-based knowledge-sharing projects should produce stories that meet the following three criteria: **meaningfulness**, **clarity** and **interest** (MCI). That is, the story should convey meaningful lessons (e.g., convey better understanding, arrive at some basic truth), and should be clear and interesting.

A case-based knowledge-sharing project, however, has to meet two more criteria: **accuracy** (A) and **brevity** (B). Since in this format project “history” is presented, the closest attention must be paid to the **accuracy** (A) of the individual stories and to the overall case study⁵⁷.

The fifth and last criterion is very pragmatic—the case must be brief. Otherwise, the busy practitioner will simply not find the time to read it and learn from it. A Harvard Business School Guide, *Developing a Teaching Case* reports that most case

studies are too long (15 pages is regarded as a short case, while a 25-page case is regarded as fairly long) and explains that, “It is easier to write a longer case because you can avoid the hard work of thinking through what exactly you want the students to focus on.” The report goes on to explain why we should insist on shorter case studies. “This extra length, however, comes at the expense of the students’ preparation. Most students are unlikely to spend more time preparing a long case—but they will simply spend more time reading and less time thinking.”⁵⁸

The cases in this book, are meant to be used as an aid in training (e.g., at NASA and DOD), and teaching (in universities), and therefore are written to adhere to the **brevity** (B) criterion. These cases, however, are primarily meant to be read and studied by individuals outside formal training systems. Since our cases are story-based (and not “dry text and numbers”), we believe that they can attract and sustain a longer “span of attention.” We therefore decided to limit the length of the cases, but not to the extent recommended by the Harvard Guide, so that each case would include about 30–40 stories.

In *ASK* magazine (as well as in the previous story-based books published by Alex and Ed), we present, following each story, several lessons that “convert” the tacit knowledge of the story into explicit knowledge. This study is based on the assumption that one of the most important objectives of research in management is the encouragement of a reflective dialogue between researchers and practitioners and among the practitioners themselves. The current project assumes that the case study is an excellent vehicle for such a dialogue. To encourage this reflective dialogue, one must minimize the explicit knowledge provided. Therefore, we decided not to share lessons that appeared in the previous story-based books and *ASK* articles (explicit lessons are presented in the epilogue, as well as in the foreword).

Since not all information can be conveyed easily via stories, and in order to meet the requirements of meaningfulness AND brevity AND clarity (without written lessons), while maintaining the reflective nature of the cases, we decided to insert brief, explanatory texts—not in a story format but in small boxes throughout the cases. These texts come from various sources, e.g., published reports in professional journals, the Internet, newspaper columns, and TV and radio programs.

The composition of the cases demanded analytical work (e.g., ensuring we covered the major players, phases, and context factors; properly explaining the stages and ramifications of a crucial decision). This analytical work had to be based on project management expertise coupled with a great deal of experience-based judgment. However, putting it all together—that is, synthesizing the stories to produce a coherent case—proved to be more of an art than a science.

The three co-authors interacted intensively during this phase of the project. Following discussions between Alex, Todd and Ed regarding the overall design and emphasis of each case, Todd would craft the first draft of the individual stories. Alex, Todd and Ed would then try to compose the entire case, while ensuring that it met the MCI and A&B criteria. This particular activity made the greatest

demands on the creative and analytical capability of all three individual co-authors, as well as requiring their utmost cooperation. To be successful, the team had to demonstrate its high levels of IQ and EQ.

This mode of operation usually required several cycles. Following each cycle, the MCI and A&B test would be performed (informally but systematically). Since the five criteria are mutually interconnected, meeting the MCI and A&B test turned out to be extremely demanding.

During this tedious process, stories were combined, decoupled, or totally eliminated from the case. We would often find that a piece of information was missing, or that we were not sure about a certain concept. The solution would usually entail an additional ad hoc phone conversation with the appropriate storyteller.

D. J. Clandinin and F. M. Connelly conclude their book with a discussion of “wakefulness.”⁵⁹ They explain that since narrative inquiry challenges accepted inquiry assumptions, we, the researchers, are expected to be wakeful, thoughtful, and constantly reflective about all our inquiry decisions. Questions falling under the wakefulness concept captured our attention throughout our work on this book, however, we found ourselves wrestling more with them during the composition of the cases. What stories should be presented in greater detail? What stories should be combined with other stories?, What auxiliary information should be included? These were just a few of the many questions we had to contend with during the final stages of the study. Moreover, as mentioned previously, we were concerned with the scarcity of attention of our prospective readers, the busy project managers; therefore, we made the decision early on to include approximately 40 testimonies per project. It is clear, therefore, that the composition of the cases involved some tough choices on our part. What instruments did we use to make these choices?

We believe that A. M. Pettigrew’s message can help us better understand how we coped with this situation.⁶⁰ Pettigrew, in a comprehensive article, followed by a lively discussion about “contextualist research” (e.g., case study) explains that there are similarities between the practices employed by contextualist researchers and the practitioners described by D. A. Schon.⁶¹ Schon studied practitioners who represented five professions—engineering, architecture, management, psychotherapy, and town planning. According to Schon, these practitioners have to cope with uncertainty, complexity, instability, uniqueness, and values conflict. These practitioners, Schon argues, employ artful inquiry, which among other things entails the capacity to hold several ways of looking at a situation at once and thus to conduct a pattern of reflection in action in a unique and uncertain situation. This reflection in action, a patterned yet informal improvisation, Schon calls “having a reflective conversation with the situation.”

Pittigrew explained that “craft” skills, and in particular interpretive skills, underlie contextualist research. The contextualist researcher, like the professionals studied by Schon, holds “a reflective conversation with the situation.” We believe that our extensive experience with narrative inquiry, and our capability to hold several ways of

looking at a situation at once—our belief in the influence of context, and more importantly, our familiarity with several project management paradigms—enabled us to develop at least some of the required interpretive skills, to maintain our wakefulness, and to make some of the difficult choices during the composition of the cases.⁶²

C. K. Riessman suggests that one way to validate the results of narrative inquiry is “correspondence.”⁶³ That is, collecting feedback from those whom we studied. We sent the final manuscript to all the participants and received feedback from all of them. The great majority were gratified to find that it represented reality as they saw it. The few corrective suggestions we received were all implemented to the full satisfaction of all the participants.

AN ONGOING SHARED VOYAGE

Our state of wakefulness throughout recent years, in which we were heavily engaged in several narrative inquiry projects, has led us to gradually see these kinds of projects in a new light.⁶⁴ In the previous section we discussed how both the practitioners and the researchers reflect in action. Each group is expected to reflect separately, first the practitioners and then the researchers who are observing and studying the practitioners. We have come to perceive, however, that to conduct successful narrative inquiries, the practitioners and researchers have to conduct major activities not just sequentially, but also simultaneously, and very closely.

First, we will discuss the production phase. This is the early phase, when the cases are produced, and then we will discuss the consumption or later phase, when the case studies are published and read.

In the introduction to his book *A Shared Authority*, M. Frisch shares a question with which he had wrestled for some time: “Early in my work in oral history, I became fascinated with the questions this method raises about authorship. Who, really, is the author of an oral history. . . Is it the historian posing questions and editing the results, or the ‘subject,’ whose words are the heart of the consequent texts?” Frisch then explains that he had come to the clear conclusion that the authorship should be shared by the researcher and the interviewee. He continues by saying that he had even considered titling his book, “A Shared Author-ity.” Frisch goes on to explain that the question of where interpretive authority is located has become a major focus of his work, and in this process he says, “I have increasingly been struck by how closely issues of authorship and interpretive authority are linked.”⁶⁵

We fully agree with Frisch. Throughout this study we felt we had equal partners—we felt that the stories were jointly authored by the storytellers and us.

The roles of the researchers and the practitioners are bound together not only during the early phase of the inquiry, when the stories are being produced, but also following their publication. As mentioned previously, Numagami questions the possibility of finding invariant laws in management studies, and suggests that the objective of management studies should be changed from a search for invariant laws to the encouragement of a reflective dialogue among researchers and practitioners. Tsoukas and Zald also stress that management research should culti-

vate the reflective capacity of the practitioners. Numagami, who promotes the use of case studies, argues, “Given that human beings have reflective capacity, the realistic goal for management researchers is not to teach scientifically naive practitioners lawlike regularities confirmed by scientifically rigorous method, but to encourage reflective dialogue among researchers and practitioners to generate more seasoned discourse on today’s management issues.”⁶⁶

Once you embrace Numagami’s point of view, that the role of the products of this study, the four case studies, is to enhance the reflective dialogue among practitioners and researchers, you understand that this study is just one leg of a long voyage. The objective of this long voyage is to arrive at a continuous reflective dialogue, and a typical cycle of this long voyage consists of three legs:

1. The practitioner copes with his/her unique and uncertain tasks at work, by “conducting a reflective conversation with the situation.”
2. The practitioner and the researcher share “author-ity” for the production of a case study. The practitioner first reflects on his/her experience in an interview. Reflecting on the transcribed material, the researcher then composes the case study.
3. The published case study serves as the main instrument in developing a reflective dialogue among researchers and practitioners.
4. A new cycle starts: equipped with a better insight of his/her unique problems, and based on reading the case studies and the reflective dialogue with researchers, the practitioner is better able to cope with his/her (old and new) unique and uncertain tasks—by “conducting a reflective conversation with the situation.”

According to the preceding description, we can see that the practitioners and researchers have an ongoing cooperation both in the production of the case studies phase, and in the consumption phase.⁶⁷ It is now very clear that the end of the current study is just the beginning of another cycle in our ongoing *Shared Voyage*.

NOTES

1. Schank, an artificial intelligence researcher at Northwestern University, convincingly argues that: “Human memory is story-based. Not all memories, however, are stories. Rather, stories are especially interesting prior experiences, ones from which we learn. . . . Not every experience makes a good story, but, if it does, the experience will be easier to remember.” See R. C. Schank, *Tell Me a Story*, (New York: Charles Scribner’s Sons, 1990), p. 12. Wilkins also reports several studies that support the conclusion that stories facilitate recall in A. L. Wilkins, “Organizational Stories as Symbols to Control the Organization,” in L. R. Pondy, P. J. Frost, G. Morgan, and T. C. Dandridge, Editors, *Organizational Symbolism: Volume 1* (Greenwich, CT: JAI Press, 1983), pp. 81–92. Moreover, Nisbett and Ross present evidence that information that is more concrete and imaginable is retained more easily in memory in R. Nisbett, and L. Ross, *Human Inference: Strategies and Shortcomings of Social Judgement* (Englewood Cliffs, NJ: Prentice–Hall, 1980).
2. T. J. Peters and R. H. Waterman, *In Search of Excellence: Lessons from America’s Best-Run Companies* (New York: Harper & Row, 1982).
3. J. T. Kidder, *The Soul of a New Machine* (Boston: Little, Brown and Company, 1981). A few other interesting and illuminating project management story books are: W. Bennis and P. W. Biederman, *Organizing Genius: the Secrets of Creative Collaboration* (Reading, MA: Addison–Wesley, 1996); T. P. Hughes, *Rescuing Prometheus* (New York: Vintage Books, 1998); B. K. Muirhead and W. L. Simon, *High Velocity Leadership: the Mars Pathfinder Approach to Faster, Better, Cheaper* (New York: HarperBusiness, 1999).
4. J. Y. Wind and J. Main, *Driving Change: How the Best Companies Are Preparing for the 21st Century* (New York: The Free Press, 1998); S. H. Haeckel, *Adaptive Enterprise: Creating and Leading Sense-and-Respond Organizations* (Boston: Harvard Business School Press, 1999); T. Petzinger, *The New Pioneers: the Men and Women Who Are Transforming the Workplace and Marketplace* (New York: Simon & Schuster, 1999); R. T. Pascale, M. Millemann, and L. Gioja, *Surfing the Edge of Chaos: the Laws of Nature and the New Laws of Business* (New York: Crown Business, 2000). To better cope with the new environment, NASA introduced the “faster, better, cheaper” initiative in the 1990s. See H. E. McCurdy, *Faster, Better, Cheaper: Low-cost Innovation in the U.S. Space Program* (Baltimore: The Johns Hopkins University Press, 2001); W. H. Lambright, *Transforming Government: Dan Goldin and the Remaking of NASA* (Arlington, VA: PricewaterhouseCoopers Endowment for the Business of Government, 2001); L. Sarsfield, *The Cosmos on a Shoestring: Small Spacecraft for Space and Earth Science*, (Santa Monica, CA: RAND Corporation, 1998). The DoD procurement system had undergone major reforms, see K. A. Harokopus, *Transforming Government: Creating the New Defense Procurement System* (Arlington, VA: The PricewaterhouseCoopers Endowment for the Business of Government, 2000); Defense Acquisition University, *Introduction to Defense Acquisition Management* (Fort Belvoir, VA: Defense Acquisition University Press, 2001).
5. Most studies are only at the exploratory stage, primarily focusing on “what is wrong with the current approach,” and not ready yet to present a comprehensive new approach. T. M. Williams, “The Need for New Paradigms for Complex Projects,” *International Journal for Project Management*, vol. 17, no. 5, pp. 269–273; L. Koskela and G. Howell, “The Underlying Theory of Project Management is Obsolete,” in *Frontiers of Project Management Research and Application: Proceedings of the PMI Research Conference* (Seattle: Project Management Institute, 2002), pp. 293–301; A. Melgrati and M. Damiani, “Rethinking the Project Management Framework: New Epistemology, New Insights,” in *Frontiers of Project Management Research and Application: Proceedings of the PMI Research Conference* (Seattle: Project Management Institute, 2002), pp. 371–380; M. E. Nissen and K. F. Snider, “Lessons Learned to Guide Project Management Theory and Research: Pragmatism and Knowledge Flow,” in *Frontiers of Project Management Research and Application: Proceedings of the PMI Research Conference* (Seattle: Project Management Institute, 2002), pp. 89–98; J. R. Turner, “Farsighted Project Contract Management: Incomplete in Its Entirety,” in *Frontiers of Project Management Research and Application: Proceedings of the PMI Research Conference*, (Seattle: Project Management Institute, 2002), pp. 121–131; A. J. Shenhar, D. Dvir, T. Lechler, and M. Poli, “One Size Does Not Fit All—True for Projects, True for Frameworks,” in *Frontiers of Project Management Research and Application: Proceedings of the PMI Research Conference* (Seattle: Project Management Institute, 2002), pp. 99–106. One industry sector, software development, has produced some innovative and more comprehensive approaches to project management. For example, W. Royce, *Software Project Management: A Unified Framework*, (Boston: Addison–Wesley, 1998); and A. Cockburn, *Agile Software Development* (Boston: Addison–Wesley, 2002). See also, T. Peters, *Reinventing Work, the Project 50* (New York: Alfred A. Knopf, 1999); A. Laufer, *Simultaneous Management: Managing Projects in a Dynamic Environment* (New York: American Management Association, 1996). While both DOD and NASA enabled project managers to deviate from the traditional practices and try

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- some new approaches, for the most part the accepted norms and procedures remained unchanged. McCurdy presents a very convincing analysis showing how NASA grew more conservative, and therefore more resistant to changes. See H. E. McCurdy, *Inside NASA: High Technology and Organizational Change in the U.S. Space Program* (Baltimore: Johns Hopkins University Press, 1993). A historical perspective on the more traditional project management practices in DOD and NASA is presented in: S. B. Johnson, *The Secrets of Apollo: Systems Management in American and European Space Programs* (Baltimore: Johns Hopkins University Press, 2002). Analysis of the DOD attempts to reform acquisition can be seen in: P.J. McIlvaine, "The Evolution of 21st Century Acquisition and Logistics Reform," *Acquisition Review Quarterly*, Fall, pp. 329-352.
6. I. Nonaka and H. Takeuchi, *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation* (New York: Oxford University Press, 1995); G.V. Krogh, K. Ichijo, and I. Nonak, *Enabling Knowledge Creation: How to Unlock the Mystery of Tacit Knowledge and Release the Power of Innovation* (New York: Oxford University Press, 2000); D.A. Garvin, *Learning in Action: A Guide to Putting the Learning Organization to Work* (Boston: Harvard Business School Press, 2000).
 7. H. Tsoukas, "Introduction: From Social Engineering to Reflective Action in Organizational Behaviour," in H. Tsoukas, Editor, *New Thinking in Organizational Behaviour: From Social Engineering to Reflective Action* (Oxford, UK: Butterworth-Heinemann, 1994), pp. 1-22; M. N. Zald, "Organization Studies as a Scientific and Humanistic Enterprise: Toward a Reconceptualization of the Foundations of the Field," *Organization Science*, vol. 4, no. 4 (1993), pp. 513-528; T. Numagami, "The Infeasibility of Invariant Laws in Management Studies: A Reflective Dialogue in Defense of Case Studies," *Organization Science*, vol. 9, no. 1 (1998), pp. 2-15.
 8. D. Leonard and S. Sensiper, "The Role of Tacit Knowledge in Group Innovation," *California Management Review*, vol. 40, no. 3 (1998), pp. 112-132.
 9. D. Vaughan, *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA* (Chicago: University of Chicago Press, 1996) pp. 200-202.
 10. T. H. Davenport and L. Prusak, *Working Knowledge* (Boston: Harvard Business School Press, 1998), p. 82; G. Roth and A. Kleiner, "Developing Organizational Memory through Learning," *Organizational Dynamics*, Autumn, pp. 43-59.
 11. K. E. Weick and L. D. Browning, "Argument and Narration in Organizational Communication," *Yearly Review of Management of the Journal of Management*, vol. 12, no. 2 (1986), pp. 243-259.
 12. K. E. Weick, *Sensemaking in Organizations* (Thousand Oaks, CA: Sage Publications, 1995), pp. 60-61. Later in the book (p. 131), following a long list of the functions of stories for sense-making in organizations, Weick says: "It is understandable that researchers might criticize stories as induction run amok and as the illegitimate use of small samples to make large points." Weick explains that that reaction is unwarranted since it overlooks the fact that stories are cues within frames that are also capable of creating frames. Paradigms are known by their examples, not by their abstract framing principles. Weick concludes that stories that exemplify frames, and frames that imply stories, are two basic forms in which the substance of sense-making becomes meaningful.
 13. P. Senge, *Fifth Discipline: the Art and Practice of the Learning Organization* (New York: Doubleday, 1990); T. H. Davenport, and L. Prusak, *Working Knowledge* (Boston: Harvard Business School Press, 1998); C. O'Dell and C. J. Grayson, *If Only We Knew What We Know* (New York: Free Press, 1998).
 14. G. Hamel and C. K. Prahalad, *Competing for the Future* (Boston: Harvard Business School Press, 1994), pp. 59-61. Argyris and Schon term unlearning as "double-loop learning," while Handy calls it "reframing." See, C. Argyris and D.A. Schon, *Organizational Learning: a Theory of Action Perspective* (Reading, MA: Addison-Wesley, 1978); C. Handy, *The Age of Unreason* (Boston: Harvard Business School Press, 1989). Laufer and his associates focused extensively on the needed unlearning in project planning. See, A. Laufer, "Essentials of Project Planning: The Owner's Perspective," *Journal of Management in Engineering, ASCE*, (April 1990), pp.162-176; G. A. Howell, A. Laufer, and G. Ballard, "Uncertainty and Project Objectives," *Project Appraisal*, vol. 8, no. 1 (1993), pp. 37-43; A. Laufer, R. L. Tucker, A. Shapira, and A. J. Shenhar, "The Multiplicity Concept in Construction Project Planning," *Construction Management and Economics*, vol. 12, no. 1 (1994), pp. 53-66.
 15. J. G. March, L. S. Sproull, and M. Tamuz, "Learning from Samples of One or Fewer," in J.G. March, *The Pursuit of Organizational Intelligence* (Malden, MA: Blackwell Business, 1999).
 16. P. F. Drucker, *Management Challenges for the 21st Century* (New York: HarperBusiness, 1999).
 17. P. Senge, *Fifth Discipline: the Art and Practice of the Learning Organization* (New York: Doubleday, 1990), p. 175.

18. Laufer describes two difficult and painful unlearning experiences he went through as a researcher. See, A. Laufer, "Perfection Is in the Details—or Is It," *ASK: Academy Sharing Knowledge, the NASA Source for Project Management*, vol. 12 (June 2003), p. 40; A. Laufer, "Letting Go Once and for All," *ASK: Academy Sharing Knowledge, the NASA Source for Project Management*, vol. 13 (August 2003), p. 40.
19. S. C. Wheelwright and K. B. Clark, *Revolutionizing Product Development: Quantum Leaps in Speed, Efficiency, and Quality* (New York: Free Press, 1992). In addition, Royce, *Software Project Management*, p.63, asserts that the old way of defining the entire problem, designing the entire solution does not work today. Instead, an iterative life-cycle process must be adopted. See also, J.A. Highsmith, *Adaptive Software Development: a Collaborative Approach to Managing Complex Systems* (New York: Dorset House Publishing, 2000), p. 85: "As the goals becomes less certain, and the number of changes to product requirements increases, success in development depends more on continuous learning about the product than on predicting its final form."
20. R. Nisbett and L. Ross, *Human Inference: Strategies and Shortcomings of Social Judgment* (Englewood Cliffs, NJ: Prentice-Hall, 1980), pp. 45–53, pp. 188–190.
21. R. McKee, "Storytelling That Moves People: A Conversation with Screenwriting Coach Robert McKee," *Harvard Business Review*, (June 2003), pp. 51-55. C. Handy, *Unreason*, pp. 229-230, suggests that reframing often needs some outside stimulus: "Reframers need to walk in other's people worlds from time to time." Heifetz (p. 252) says "Leadership is both active and reflective. One has to alternate between participating and observing." Using a dancing metaphor he suggests that to discern the larger patterns on the dance floor: "we have to stop moving and get on the balcony." See, R.A. Heifetz, *Leadership without Easy Answers* (Cambridge, MA: Harvard University Press, 1999). We believe that listening, discussing, and reading stories, may often serve as a substitute for "walking in other's people worlds" or "getting on the balcony."
22. In 1991, Laufer was invited to consult to Procter & Gamble (P&G). He was given a broad charter—to use his research products in order to improve project management at P&G. His research products, derived from studies in a dynamic environment, called for adding on (learning) some new project management principles and tools, but also, and more importantly, they called for letting go (unlearning) some old ones. Not surprisingly, he found that it was not easy to change a mindset. He suspected, however, that people's minds are changed more through observation than through arguments, and that real-life stories told by credible and successful managers—colleagues from their own company—may to some extent serve as a substitute for observation. Therefore, he proposed the use of storytelling as the primary tool for introducing change at P&G. The book, which he co-authored together with three P&G project managers, and which contains 70 stories told by 28 project managers is still in use at P&G. While no hard data can be furnished to establish the direct impact of the book, and how much it helped people change their mindset, one thing became very clear immediately following the publication of the book: the book enriched the readers' vocabulary, particularly regarding project uncertainty, and made them more aware of "planning assumptions," two key notions that, for many people at the time, clearly fell under unlearning. A. Laufer, R. C. Volkman, G. Davenport, and S. Terry, Editors, *In Quest of Project Excellence through Stories* (Cincinnati, OH: Procter & Gamble, 1994).
23. J. Martin and M. E. Powers, "Organizational Stories: More Vivid and Persuasive than Quantitative Data," in B. M. Staw, *Psychological Foundations of Organizational Behavior* (Upper Saddle River, NJ: Prentice Hall), pp. 161-168; A. L. Wilkins, "The Creation of Company Cultures: The Role of Stories and Human Resource Systems," *Human Resource Management*, vol. 23, no. 1 (1984), pp. 41-60; T. Peters, and N. Austin, *A Passion for Excellence* (New York: Random House, 1985); L. S. Myrsiades, "Corporate Stories as Cultural Communications in the Organizational Setting," *Management Communication Quarterly*, vol. 1, no. 1 (1987), pp. 84-120; D. M. Armstrong, *Managing by Storying Around* (New York: Doubleday Currency, 1992); Laufer, *Simultaneous Management*; N. L. Breuer, "The Power of Storytelling," *Workforce*, vol. 77, no. 12 (1998), pp. 36-41.
24. A. S. Buckler, and K. A. Zien, "The Spirituality of Innovation: Learning from Stories," *Journal of Product Innovation Management*, vol. 13, no. 5 (1996), pp. 391-405; G. Shaw, R. Brown, and P. Bromiley, "Strategic Stories: How 3M is Rewriting Business Planning," *Harvard Business Review*, (May-June 1998), pp. 41-50; T.A. Stewart, "The Cunning Plots of Leadership," *Fortune* (September 7, 1998), pp. 165-6; E. Weil, "Every Leader Tells a Story," *Fast Company* (June-July 1998), pp 38-40; B. Kaye, and B. Jacobson, "True Tales and Tall Tales: the Power of Organizational Storytelling," *Training and Development* (March 1999), pp. 45-50.
25. G. Shaw, R. Brown, and P. Bromiley, "Strategic Stories: How 3M Is Rewriting Business Planning," *Harvard Business Review* (May-June 1998), pp. 233-244.

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26. Drucker, *Management Challenges*, p. 5.
27. R. Kaniger, *The Best Way: Fredrick Winslow Taylor and the Enigma of Efficiency* (New York: Viking, 1997).
28. H. Mintzberg, *The Rise and Fall of Strategic Planning* (New York: Free Press, 1994).
29. Nonaka and Takeuchi, *Knowledge-Creating Company*, pp. 35-36.
30. M. J. Roberts, *Developing a Teaching Case*, Harvard Business School, January 2001, pp. 1-10.
31. G. Johns, "In Praise of Context," *Journal of Organizational Behaviour*, vol. 22 (2001), pp. 31-42. M. Gladwell, *The Tipping Point* (New York: Little, Brown and Company, 2000). Gladwell cites research and provides examples of how ordinary people underestimate the power of context.
32. Highsmith, *Adaptive Software Development*, p. 5. In addition, Beck who is extremely critical of "Taylorism" (i.e. the principles of "scientific management"), says: "My experience is that these principles make no sense as strategies for software development, no business sense, and no human sense." These are Beck's words in his annotated bibliography of the book by F.W. Taylor, *The Principles of Scientific Management*, 2nd ed. (1st ed. 1911), (Mineola, NY: Dover Publications, 1998). See, K. Beck, *Extreme Programming Explained; Embrace Change* (Boston: Addison-Wesley, 2000), p. 172. Royce, *Software Project Management*, pp. 209-220 also recommends tailoring the process: "While there are some universal themes and techniques, it is always necessary to tailor the process to the specific needs of the project at hands." In his recent book, *The Business of Software*, Cusumano, who has studied software development since 1985, and has written extensively on the subject, elaborates on the issue of best practices in software development. He concludes that, despite the desire of many managers to define "one best-development process," there is "no one best process." He further recommends that "software development groups and projects within the same organization usually need to define different kinds of processes for different kinds of products, markets, and customer requirements." See, M. A. Cusumano, *The Business of Software* (New York: Free Press, 2004), pp. 161-162. Vaughan, *Challenger Launch Decision*, pp. 201-203, stresses that "an important but unacknowledged aspect of engineering work consists of generating rules that are tailored to a specific technical aspect," and that "engineering work is guided by a system of flexible rules tailored and retailored to suit an evolving knowledge base."
33. National Aeronautics and Space Administration, *NASA Program and Project Management Processes and Requirements* (Washington, DC: NASA Office of Chief Engineer, NPG:7120.5A, 1998).
34. See, E. Hoffman, "Hurry to the Classroom, Your Instructor Just Died," in A. Laufer and E. Hoffman, *Project Management Success Stories: Lessons of Project Leaders* (New York: John Wiley & Sons, 2000), pp. 54-57.
35. Strategic Resources, Inc., *NASA APM-23 Special Study Group Fast Track Study* (Falls Church, VA: Strategic Resources, Inc. in conjunction with the NASA Program/Project Management Initiative, 1996).
36. In 1998, Laufer, together with Hoffman, launched another storytelling project, this time focusing on government agencies. Thirty-six project managers (20 of them from NASA) were asked to document their experiences in story form. One of the major findings of their study was that, in contrast to the prevailing professional literature, successful projects require strong leadership. See, Laufer and Hoffman, *Project Management Success Stories*. In July 1999, Hoffman, as the Director of the NASA's Academy of Program and Project Leadership (APPL), and Laufer, convened the first Forum for Master Project Managers. The Forum meets twice a year, and draws about 50 of the best project managers in NASA (and a few from outside NASA), for sharing knowledge via stories. The hallmark of the forum is the open and rich dialogues, in small and large groups, that follow the presentation of the stories. See, T. Post, "Conference Report: 2001 Masters Forum, Born Under a Good Sign," ASK: Academy Sharing Knowledge, the NASA Source for Project Management, January 2002, pp. 45-49. Towards the end of 2000, Post joined Hoffman and Laufer and together they established ASK magazine. ASK, which stands for "Academy Sharing Knowledge," is published bimonthly by APPL and features the stories that were presented and discussed at the Masters Forums, as well as a few stories collected by its editors. Working closely, since 1998, with many project managers at NASA, the editors were able to observe some changes, where people in the field were encouraged to exercise more tailoring, however, the changes are still slow. The fact that the professional literature has not focused on the tailoring issue makes it even harder to change a mindset at the work place. See, for example, *The Project Management Institute, A Guide to the Project Management Body of Knowledge* (Upper Darby, PA, Project Management Institute, 2000). This guide is considered "the bible" of the Project Management Institute, the leading project management association in the world. This detailed handbook devotes only half a page to "Customizing process interactions," on p. 37.
37. H. Zukier, "The Paradigmatic and Narrative Modes in Goal-Guided Inference," in R. M. Sorrentino and E.T. Higgins, Editors, *Handbook of Motivation and Cognition* (New York: Guilford, 1986), pp. 465-502. Also,

- Clandinin and Connelly compared between what they termed the grand narrative and narrative thinking (narrative account of an experience), to similarly find that in narrative thinking context is ever present. They concluded: "In the grand narrative the universal case is of prime interest, in narrative thinking, the person in context is of prime interest." See D. J. Clandinin and F. M. Connelly, *Narrative Inquiry: Experience and Story in Qualitative Research* (San Francisco, CA: Jossey-Bass, 2000), p. 32. Also, Klien stresses the fact that stories represent a specific context and provide details about this context, while Polkinghorne says, "Narratives are context sensitive, both in their telling and in the meaning they give to the events," in G. Klien, *Sources of Power: How People Made Decisions* (Cambridge, MA: MIT Press, 2001); and D. E. Polkinghorne, *Narrative Knowing and the Human Science* (Albany, NY: State University of New York Press, 1988), p. 165.
38. Numagami, "Infeasibility of Invariant Laws, goes further than the HBS concept mentioned above (claiming that there are general principles that must be tailored to the situation), and questions the possibility of finding invariant laws in management studies. First he shows that though various concepts and techniques have been developed to make the case study method sufficiently rigorous, the method often fails to meet two primary criteria: reliability and replicability, and external validity. However, he goes on to show that these two criteria are irrelevant not only to the case study, but for any method of management studies—they simply can't be met. Without those two criteria, the validity of the case study can still be forcefully reasserted.
 39. Tsoukas, "Social Engineering to Reflective Action," Zald, "Organization Studies.
 40. Numagami, "Infeasibility of Invariant Laws." See also, M. Polanyi, *The Tacit Dimension* (New York: Doubleday, 1966); D. A. Schon, *The Reflective Practitioner* (New York: Basic Books, 1983).
 41. It seems that the HBS approach and Numagami's and Tsoukas' approach would agree that one way to facilitate a shift to a context-specific paradigm is by exposing practitioners to a greater variety of experiences. We believe that the variety of stories within each case, and the variety of the story-based cases, should encourage the reader to emulate many of the situations found within *Shared Voyage*.
 42. This simplified analysis does not take into account the changes in context factors throughout the life of a project. For example, early on, the main driver of the JASSM project was schedule, while later it was driven primarily by cost considerations.
 43. We described earlier our major storytelling studies: A. Laufer, R. C. Volkman, G. Davenport, and S. Terry, Editors, *In Quest of Project Excellence through Stories* (Cincinnati, OH: Procter & Gamble, 1994); A. Laufer and E. Hoffman, *Project Management Success Stories: Lessons of Project Leaders* (New York: John Wiley & Sons, 2000); the Forum for Master Project Managers, established in 1999, and *ASK* magazine, published first in January 2001. In 2002, we launched a new knowledge sharing project, this time for less experienced project managers. These groups meet at the NASA Field Centers to discuss the stories presented in *ASK*, as well as to discuss their own stories. See, D. Lee, "Transfer Wisdom Workshops: Coming to a NASA Center Near You," *ASK: Academy Sharing Knowledge, the NASA Source for Project Management* (June 2003), pp. 15–17.
 44. R. K. Yin, *Applications of Case Study Research* (Thousand Oaks, CA: Sage Publications, 1993); R. K. Yin, *Case Study Research: Design and Methods* (Thousand Oaks, CA: Sage Publications, 1993); R. E. Stake, *The Art of Case Study Research* (Thousand Oaks, CA: Sage Publications, 1995); C. C. Ragin and H. S. Becker, *What is a Case? Exploring the Foundations of Social Inquiry* (New York: Cambridge University Press, 1992); J. R. Feagin, A. M. Orum, and G. Sjoberg, *A Case for the Case Study* (Chapel Hill, NC: University of North Carolina Press, 1991); W. G. Dyer, A. L. Wilkins, "Better Stories, Not Better Constructs, to Generate Better Theory: A Rejoinder to Eisenhardt," *Academy of Management Review*, vol. 16, no. 3 (1991), pp. 613–619.
 45. P. Thompson, *The Voice of the Past: Oral History* (Oxford, UK: Oxford University Press, 2003); D. A. Ritchie, *Doing Oral History* (New York: Twayne Publishers, 1995); D. A. Ritchie, *Doing Oral History: a Practical Guide* (Oxford, UK: Oxford University Press, 2003); D. K. Dunaway and W. K. Baum, Editors, *Oral History: an Interdisciplinary Anthology* (Walnut Creek, CA: AltaMira Press, 1996); E. M. McMahan and K. L. Rogers, Editors, *Interactive Oral History Interviewing* (Hillsdale, NJ: Lawrence Erlbaum Associates, 1994); M. Frisch, *A Shared Authority: Essays on the Craft and Meaning of Oral and Public History* (Albany, NY: State University of New York Press, 1990); R. Perks and A. Thomson, Editors, *The Oral History Reader* (London: Routledge, 1998); G. Roth and A. Kleiner, *Car Launch: the Human Side of Managing Change* (Oxford, UK: Oxford University Press, 2000); A. Kleiner and G. Roth, *Oil Change: Perspective on Corporate Transformation* (Oxford, UK: Oxford University Press, 2000).
 46. Clandinin and Connelly, *Narrative Inquiry*; Schank; Polkinghorne, *Narrative Knowing*; M. R. Jalongo, J. P. Isenberg, and G. Gerbracht, *Teachers' Stories: from Personal Narrative to Professional Insight* (San Francisco,

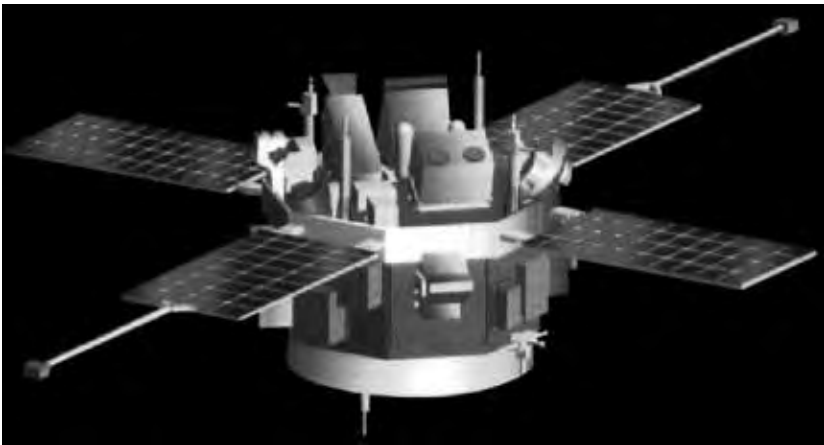
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- CA: Josey-Bass Publishers, 1995); Y. Gabriel, *Storytelling in Organizations: Facts, Fictions, and Fantasies* (Oxford, UK: Oxford University Press, 2000); C. K. Riessman, *Narrative Analysis* (Newbury Park, CA: Sage University Press, 1993); D. M. Boje, *Narrative Methods for Organizational and Communication Research* (London: Sage Publications, 2002); J. Bruner, *Making Stories: Law, Literature, Life* (New York: Farrar, Straus and Giroux, 2002); E. G. Mishler, *Storylines: Craftartists' Narratives of Identity* (Cambridge, MA: Harvard University Press, 1999); A. Simmons, *The Story Factor: Secrets of Influence from the Art of Storytelling* (Cambridge, MA: Perseus Publishing, 2001).
47. Laufer, et al., *In Quest of Project Excellence*.
 48. Laufer and Hoffman, *Project Management Success Stories*
 49. ASK: *Academy Sharing Knowledge, the NASA Source for Project Management*.
 50. Bennis and Biederman, *Organizing Genius*.
 51. R. H. Waterman, *What America Does Right: Learning from Companies that Put People First* (New York: W.W. Norton & Company, 1994).
 52. To preserve interest, induce reflectivity, and allow for full grasp of the meaning of the data, the specific data indicating the success of the various projects are not presented here, but rather, as a genuine story unfolds, throughout the stories in each case.
 53. D. Bohm, *On Dialogue* (New York, Routledge, 1996); Nonaka and Takeuchi, *Knowledge-Creating Company*; A. Fontana and J. H. Frey "The Interview: from Structured Questions to Negotiated Text," in N. K. Denzin, and Y. S. Lincoln, Editors, *Handbook of Qualitative Research* (Thousand Oaks, CA, Sage Publications, 2000).
 54. Numagami, "The Infeasibility of Invariant Laws. We, the interviewers, found ourselves constantly acquiring new insight, both learning and unlearning, and it was our clear impression that it was also true regarding most of the interviewees. In a presentation delivered to the NASA Forum of Master Project Managers (18 August 2003, Annapolis, MD), Linda Rutledge told the group that following the day of the interviews for the current study, she and Brian, who also participated in the interview, had shared their impression, to find out that, "that day was probably one of the most enjoyable and fruitful days that they have ever experienced throughout their career in the Air Force."
 55. In successful projects done under tough constraints there are always failures on the way to success. In general, we want to learn from successful projects and successful people, and very often if the whole project is a failure, the key players would be reluctant to share their stories. However, failure stories often provide a very powerful, unique, and memorable learning experience.
 56. Based on the successful experience we have accumulated in collecting stories for many years, we decided not to use an interview instrument. Unfortunately, the first interview was not completely productive. The group was very responsive, the atmosphere was very open, yet the 3-hour meeting did not yield sufficient useful material. There was a feeling of a lack of focus. We became very concerned. We speculated that it was the result of interviewing a group of people (rather than an individual, which was the way we had conducted interviews prior to this study), and therefore decided to prepare an instrument for the next interview. We decided to use the list of project management principles that Laufer had formulated based on his previous research. The list is basically a summary of his recent research papers, and primarily of the two books he authored or co-authored, *Simultaneous Management: Managing Projects in a Dynamic Environment* (1996), op. cit, and *Project Management Success Stories* (2000), op. cit. We felt that since most of the participants were familiar with these two books no significant bias would occur, and we felt that using the brief list would sharpen the focus during the interview. During the following few meetings we attempted to use this instrument; however, surprisingly, we found that it was not necessary. People just did not pay attention to the list of principles, and the interviews were still very fluid and productive. In hindsight, we concluded that the first interview was not fully productive probably because of our own deficient preparations. Later on we did not even bring the instrument to the interviews.
 57. Moving from a knowledge-sharing project, based on individual and independent stories, to a research project, based on multiple and interdependent groups of stories (i.e., the case study), one must pay closer attention to the accuracy of the information. Though the accuracy of individual stories can't be ignored, it is widely acceptable that there is room for a fruitful discussion regarding "fact and fiction" or "narrative truth and narrative relativism." See, Clandinin and Connelly, *Narrative Inquiry*, pp. 85–86, 179–181. See also, Riessman, who claims that the historical truth is not the primary issue since storytelling assumes a point of view, and trustworthiness and not truth is the key for validating stories, Riessman, *Narrative Analysis*, pp. 64–65. While case studies can also encourage or even present multiple perspectives, it is impossible to produce a meaningful case composed of multiple stories told by multiple actors without

- paying greater attention to accuracy. See Stake, *Case Study Research*, pp. 107-120, and Yin, *Applications of Case Study Research*, pp. 144-146.
58. M. J. Roberts, *Developing a Teaching Case* (Boston: Harvard Business School Press, 2001), p. 9.
 59. Clandinin and Connelly, *Narrative Inquiry*, pp. 184-185.
 60. A. M. Pettigrew, "Contextualist Research: a Natural Way to Link Theory and Practice," in E.E. Lawler, A.M. Mohrman, S.M. Mohrman, G.E. Ledford, and T.G. Cummings, Editors, *Doing Research That Is Useful for Theory and Practice* (San Francisco, CA, Jossey-Bass, 1985), pp. 222-274.
 61. Schon, *The Reflective Practitioner*.
 62. Researchers in both the natural and social sciences usually start their research with a theory in mind. See, I. I. Mitroff, *The Subjective Side of Science* (Amsterdam: Elsevier, 1974); J. Walton, "Analyses of Research Experiences: Making the Theoretical Case," in C. C. Ragin, and H. S. Becker, Editors, *What Is A Case? Exploring the Foundations of Social Inquiry* (New York: Cambridge University Press, 1992); C. C. Ragin, "Casing and the Process of Social Inquiry," in C. C. Ragin, and H. S. Becker, Editors, *What is a Case? Exploring the Foundations of Social Inquiry* (New York: Cambridge University Press, 1992). For a narrative inquiry that potentially can be biased through both the interviews and their interpretations, it is crucial that the researchers will be aware of multiple paradigms, be open to surprises and, most importantly, be willing to allow themselves to go through a difficult unlearning experience. See, Laufer, "Perfection Is in the Details" Laufer, "Letting Go."
 63. Riessman, *Narrative Analysis*, pp. 66-67.
 64. A. Laufer, R. C. Volkman, , G. Davenport, and S. Terry, Editors, *In Quest of Project Excellence through Stories* (Cincinnati, OH: Procter & Gamble, 1994); A. Laufer and E. Hoffman, *Project Management Success Stories: Lessons of Project Leaders* (New York: John Wiley & Sons, 2000).
 65. Frisch, *Shared Authority*, pp. x-xi.
 66. Numagami, "The Infeasibility of Invariant Laws"; Tsoukas, "Social Engineering to Reflective Action"; Zald, "Organization Studies; In his book, Weick presents a novel concept, "Every manager a historian", see Weick, *Sensemaking in Organizations*, pp. 184-185. According to this concept, when one feels compelled to declare that a decision has been made, the gist of that feeling is that there is some outcome at hand that must have been occasioned by some earlier choice. Therefore, Weick concludes that a decision is an act of interpretation rather than an act of choice, and that good decisions may arise as much from an accurate reading of what has been going on as from an accurate reading of what is going on. Accordingly, dialoging and reflecting on project stories may significantly enhance the world of history that is available to the project manager, as well make him more aware of his own project stories. The various forums for sharing knowledge that NASA has created in recent years, go a long way towards accomplishing this vision of enhancing a reflective dialogue among practitioners and among practitioners and researchers. See, Post, "Conference Report: 2001 Masters Forum; Lee, "Transfer Wisdom Workshops."
 67. D. A. Schon, "Knowing-in-Action; the New Scholarship Requires a New Epistemology," *Change* (November-December 1995), pp. 27-34. Schon recommends: "The relationship between "higher" and "lower" schools, academic and practice knowledge, needs to be turned on its head. We should think about practice as a setting not only for the application of knowledge but for its generation. We should ask not only how practitioners can better apply the results of academic research, but what kinds of knowing are already embedded in competent practice." We believe that the concept of a "shared voyage" is a major step towards turning the relationship on its head.

Chapter 2

LEADING QUIETLY WITH COMMON SENSE: ACE



ADVANCED COMPOSITION EXPLORER

NASA's Advanced Composition Explorer (ACE) project officially began in 1991, although the scientific objectives of the mission had been plotted nearly a decade earlier. Budgeted for \$141.1 million, the project appeared to be quickly outspending its resources when work began, and it was soon in jeopardy of being cancelled. Bringing the project under control required a number of common sense management strategies that—as the saying goes—were not so common.

In the end, the cooperation of the three main organizations involved turned the project around. Overall NASA responsibility for the mission was in the hands of the Explorer Project Office of the Goddard Space Flight Center in Greenbelt, Maryland. The Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Maryland was responsible for building the spacecraft. The lead scientific institution was the California Institute of Technology (Caltech) in Pasadena, under whose direction 20 other institutions worked. When organizational cultures collided on ACE, the leaders learned to cope with their respective differences.

ACE launched successfully from Cape Canaveral, Florida on 25 August 1997.

Shared Voyage: Learning and Unlearning from Remarkable Projects

SOURCES:

NASA GODDARD SPACE FLIGHT CENTER

Don Margolies, Project Manager

Frank Snow, Flight Operations and Ground System Manager

John Thurber, Observatory Manager

CALIFORNIA INSTITUTE OF TECHNOLOGY

Dr. Edward Stone, Principal Investigator

Allan Frandsen, Payload Manager

Gerald Murphy, Payloads Systems Engineer

JOHNS HOPKINS APPLIED PHYSICS LABORATORY

Mary Chiu, Program Manager for Spacecraft Development

Judi von Mehlem, Spacecraft Systems Engineer

ONE

All Eyes Fell on Me

DR. EDWARD STONE

PRINCIPAL INVESTIGATOR

CALIFORNIA INSTITUTE OF TECHNOLOGY

The first meeting of the core science group that proposed the NASA Advanced Composition Explorer mission, or ACE, took place at the University of Maryland in the early 1980s. There were probably six or seven of us present. Everyone knew each other; we had worked on other NASA missions, and some of us had built instruments together. The early 1980s may sound like an early beginning for a mission that launched in 1997, ahead of schedule no less, but it goes to show how long it takes to accomplish projects like this.

Our interest in doing a mission of this nature originated back in the late 1970s with the International Comet Explorer, or ICE. The instrument that I helped design for ICE worked for just three months. An integrated circuit failed and the instrument stopped collecting data. It was a terrible disappointment to me personally to have developed a new technology but be able to use it for only three months. When the ACE science group met at the University of Maryland, we knew that we could build much better instruments with the advances that had been made, and so we were quite excited to propose such a mission.

At the time, NASA wasn't reviewing proposals for new missions. When it came down to who would be the leader of our group, all eyes fell on me. I was the Project Scientist on Voyager, a high-profile NASA mission, and I was considered a known quantity by the Agency. People knew how I did things and how I managed science. They also knew that Voyager had been going well. While I was very busy at the time, I agreed to lead ACE because I had been promoting this kind of mission for several years.

We sent in an unsolicited proposal, and of course NASA didn't know what to do with it. As expected, the proposal went nowhere, but it raised the visibility of our group, and that was a start. When an opportunity came along to propose a new mission in the latter part of the 1980s, our science group got together and said, "Let's try again." The proposal we put together this time was based on the one we did earlier, but we re-addressed the science issues and asked ourselves, "What do we know now that we didn't know five years ago?"

Patience paid off. We proposed ACE as an Explorer-class mission to be run out of NASA's Goddard Space Flight Center, and it was selected with three others for a concept study. We did the study, where we worked out exactly how we were going to manage this thing, wrote a report, and NASA downselected us in 1988. Two members of our science group were from the Johns Hopkins Applied Physics Laboratory (APL), and they were quite experienced building the type of spacecraft that we thought we needed, so we proposed using a spacecraft built by APL.

And that is how this project got underway. By the time we finally were funded in 1991 it seemed as though we had come a long way, but it was just the beginning. Many more difficulties, challenges, uncertainties, and a bounty of learning lay ahead.

TWO

Judgment Calls

DON MARGOLIES

PROJECT MANAGER

GODDARD SPACE FLIGHT CENTER

In the early '90s, the NASA Explorers Program budget was one big pot of money. If one mission sucked up most of the funding, the other projects would have to work with what was left. At the start of ACE, I had the choice of spreading the money among all the players, or focusing on the elements that posed the greatest risks on the project. I responded by putting the bulk of the money into trying to identify the key risks in the development of the science instruments and mitigating these to the best extent that we could at the earliest stage possible. To do this, I had to hold back spacecraft development at the Johns Hopkins Applied Physics Laboratory (APL).

The greatest uncertainty on a science mission is in the development of the instruments. There were nine on ACE, five of which were new. Because I was limited as to how much money I could get in the early stages of the project, the question was, "What was the best way to use it?"

In holding APL back by three to six months, I knew I could be shooting myself in the foot if they were not able to recover. But I believed that even with a slow start APL would be able to catch up. Why? This was my third mission with APL, and I thought I understood their organizational culture. Mary Chiu, the APL Program

ACE Science Objectives

In the early part of the twentieth century, scientists learned that matter from space is bombarding Earth. With the advent of space missions, it has been recently discovered that some of these particles come from gas clouds outside our solar system. The primary purpose of the Advanced Composition Explorer, ACE for short, is to study these particles. We hope to learn more about what matter is there: about its composition, where it comes from, and what it tells us about the evolution of the larger universe.

Source: National Aeronautics and Space Administration, *Advanced Composition Explorer* (Greenbelt, MD: Goddard Space Flight Center, NP-1997(07)-021-GSFC, August 1997), p. 1

Manager, was new to me, but I knew most of the other key people on the project. APL had built spacecraft many, many times before. My concerns about APL being able to do the job actually were quite minimal. On the other hand, no one was certain how effectively we could mitigate the risks with those problem instruments.

You're never right 100 percent of the time. Still, you have to go with your judgment. Experience counted for a lot here. Once we secured more funding, I told APL to start ramping up on the spacecraft development. As it turned out, they were able to catch up.

THREE

Reality Planning

DON MARGOLIES

PROJECT MANAGER

GODDARD SPACE FLIGHT CENTER

On another project before ACE, I went to visit my contractor, and met with the scheduler and project manager. We went into their war room, and there were schedules all over the wall. They were wonderful, as detailed as can be, and so I had to ask, "Who developed the schedule?"

Explorer Program Characteristics

The NASA Explorers Program is characterized by relatively low- to moderate-cost and small- to medium-sized satellites capable of being built, tested, and launched in a short time compared to the large observatories. The Explorer missions are capable of supporting various scientific disciplines. ACE fits this mold very well and is part of the overall Explorers Program administered by the Astrophysics Division of the Office of Space Science (OSS) at NASA Headquarters.

Source: National Aeronautics and Space Administration, *Advanced Composition Explorer (ACE): Lessons Learned and Final Report* (Greenbelt, MD: NASA Goddard Space Flight Center, July 1998), p.16.

The scheduler said, "I did."

And so I asked another question, "Did the people doing the work have input?" He said, "No."

The next day I notified the contractor that I wanted the project manager and his scheduler removed from the project, and I told the contractor to start building schedules that were representative of the work that really needed to be done.

Here were these wonderful schedules, detailing every single thing you ever wanted to know about the project—and it was totally false. It had no basis in reality whatsoever.

As a project manager, there are certain things you can dictate: the end date, maybe certain review period dates; but in terms of everything else that you have to do, you've got to ask the people who are doing the job. When you're starting a project from scratch, you build a schedule that's appropriate by working with your team. You talk to the people doing the work. You find out what they have to do, and how long it's going to take. Now, even if you do it that way, your schedules can be fallible, but at least you'll have something that everybody has bought into because they helped to develop it.

The challenge on ACE was going to be working with 20 different science institutions. It was a big team, spread out widely across the United States and parts of Europe, and while they were all experts in their own scientific and technical domains, their reputations were not earned by delivering projects on schedule. So the real challenge was making sure all of our schedules converged on the same launch date.

FOUR

“What Do I Need To Do?”

DR. EDWARD STONE

PRINCIPAL INVESTIGATOR

CALIFORNIA INSTITUTE OF TECHNOLOGY

I didn't know Don Margolies before he was selected by the Explorers Program office to manage the ACE mission, but when they were in the process of selecting him I learned about his background as a project manager, and it seemed like he had the right kind of approach and experience to deal with this kind of

When Uncertainties Abound

Even one of the “design-to-print” instruments, SWIMS, turned out to be more difficult than anticipated. This occurred when it was learned that its predecessor instrument on the WIND mission was limited by the helium background in space. An unplanned development effort ensued and significant redesign resulted before the modified SWIMS instrument was finished.

Source: National Aeronautics and Space Administration, *Advanced Composition Explorer (ACE): Lessons Learned and Final Report* (Greenbelt, MD: NASA Goddard Space Flight Center, July 1998), p.18.

science mission. He was not one to try to do too much and risk squandering project resources on unnecessary requirements, or one to aim too low in terms of how much science the project should attempt to achieve.

I had no intention of stepping on his toes. He was the project manager for the mission and was responsible for getting us to launch on time and on budget. I made it clear that he was to use me as he needed. I wasn't looking for someone to reassure me that everything was going fine. What I was looking for in a project manager was someone to tell me what I needed to do as Principal Investigator (PI) to impact the success of the project.

I realized the tension that exists sometimes between project managers and scientists. On the successful science projects I've worked on, project managers have been willing to listen and learn from their PIs, and the same has been true the other way around. Successful PIs will listen and learn from project managers.

With Don, it became clear to me early on that he understood that we were working together to get the most mission we could within our cost and schedule constraints.

FIVE

Weather Reports

DON MARGOLIES

PROJECT MANAGER

GODDARD SPACE FLIGHT CENTER

Dr. Stone and I set up a schedule to talk with each other on the phone every week. In the early stages of the project, much of what was about to unfold was still up in the air. You might say the spacecraft itself was about the only thing not in the air. I thought it was crucial to the success of the project that Dr. Stone know everything that was going on—and if something happened that involved the development of the instruments, he could be on it right away.

Even if it was just to say that the weather was nice in California and there was nothing much happening here at Goddard, we always kept the appointment.

SIX

A PI-Mode Mission

DON MARGOLIES

PROJECT MANAGER

GODDARD SPACE FLIGHT CENTER

“ACE was the first full-sized Explorer mission to use the Principal Investigator (PI) mode. The PI (Dr. Stone) could have also been the ACE project manager, if he had wanted. Theoretically, he had full responsibility for running the mission.

Truth be told, everybody knew that this was a Goddard project under contract to the PI institution at Cal Tech.

To his credit, Dr. Stone did not say, ‘As the PI on this mission, I am going to own the whole thing.’ He had the good judgment to recognize Goddard’s experience in project management.

When you think of a project manager in the correct sense, you think of a person who is out there, really, literally managing the day-to-day activities of a project. That’s not what most scientists want to do, frankly, when it’s science they’re mostly concerned about. At this time, in the early 1990s, it was still an open question whether projects could be run by PI organizations. Therefore, ACE was also considered something of a management experiment.”

De-Scoping to Reduce Risk

“On ACE, we didn’t have a formal risk mitigation plan, but in a way the de-scope plan forced us to think about the things we could do to mitigate risk. Presently, all NASA projects must have a formal risk mitigation plan. That is a structured way to force you to think about the bad things that could happen on the project and what you can do to address them. Even though we didn’t write the big “R” on the wall, risk was a part of all of our decisions.

“This decision came out of a meeting I had with Jim Barrowman. Jim was the Explorers program manager at the time. I don’t remember whether Jim talked about a de-scope plan or I talked about it, but out of this meeting we came up with the idea for a de-scope plan and applied it to all parts of the project.”

—Don Margolies

SEVEN

Stopping at ‘Good Enough’

DON MARGOLIES

PROJECT MANAGER

GODDARD SPACE FLIGHT CENTER

Early on in the project, before we had been confirmed, we looked at our budget and it looked as though we were going to exceed our total resources by \$22 million. The word came back from NASA Headquarters that they wouldn’t allow us to continue with that kind of overrun.

I spent several months trying to find ways to whittle down the overrun. What I set out to do was to establish a mutual agreement with everyone that “good

enough” is good enough. Set your requirements and stick to those requirements. Once you meet the requirements, spend no additional money to make it better.

Scientists want to get as much science out of a mission as they possibly can. Anything they can do to make the science better or get more science is ideal from their point of view. From a project manager’s perspective, making things better tends to cost money and take time. Hence, a project manager has a natural tendency to want to resist the kind of requirements a scientist would like to see added.

Now let me wrap this around some other issues. In my experience on other NASA missions, and this is going back years, project managers and scientists have always had a contentious relationship over what the latter consider “good enough” science. A scientist specifies a requirement to improve the performance of his instrument. The spacecraft could operate successfully, but it can’t meet that specific requirement—so we have to spend an extensive amount of time and money to change the spacecraft so that it can meet the requirement. On the other hand, had the scientist asked, “Do I really need that requirement?” we might not have had to spend all that extra time and money.

What I asked everyone to do—and this covered not only the instruments, but also the spacecraft, ground operation, integration, and testing—was to identify what their de-scopes would be if necessary, when they would have to be taken, and how much they would save. So, for instance, scientists were forced to go back and look at their instruments and ask themselves, “How much can I save if I take out a circuit board? How much performance will I lose by doing that? Will I lose any performance?” Out of this exercise came a document: our de-scope plan.

The reason for asking this was that I wanted Headquarters to make a commitment to us in writing that they would give us stable funding. The way to seal the agreement was to assure them that we were able to control the program and not run over cost. The only way to do that was to say what we would do if we got in trouble. We were willing to commit to a fixed price if they would guarantee stable funding. Headquarters agreed, and this was crucial to our forward progress because it eliminated a major source of uncertainty, i.e. whether the mission would be cancelled. Soon enough we got the mission back on budget, without having to do any de-scoping.

I discussed the whole thing with Dr. Stone, and he was in favor of having a de-scope plan right away. The objective was to get ACE confirmed. I knew that if we were going to get the scientists to buy-in on “stopping at good enough,” it had to be Stone who sold it to them. He said to me in one of our first meetings, “Don’t reassure me. Tell me what you need me to do.” It was one of many occasions when I took him up on the offer. Without his help, I dare say ACE would have been a much different project, and we probably would not have been confirmed.

EIGHT

Desirements and Requirements

DR. EDWARD STONE

PRINCIPAL INVESTIGATOR

CALIFORNIA INSTITUTE OF TECHNOLOGY

Part of my job as the Principal Investigator of the project was to find a way to be responsive to Don. The other part of my job as the head of the science team was to get us to work as a homogeneous unit.

Some of the scientists felt that we should not have to make any compromises on requirements. Scientists prefer to draw a large circle around their requirements because they know somewhere in there is what they need, and it is easiest just to draw the circle large—meaning enough mass, enough power, enough whatever, because then you can say, “I know that’s going to do it.” That’s fine, if you can afford anything you want, but it’s probably not the way to optimize the mission.

This is the difference between desirements and requirements. For example, in our initial studies we looked at having an additional amplifier put on the spacecraft to increase the data rate, but there is a trade-off; adding another piece of equipment requires more power. Yes, it would have been nice to have twice the data rate, but we couldn’t; it was not the right cost/power trade-off. So it seemed reasonable to back off on that particular requirement.

When you have to make the circle smaller—meaning less power, less mass, less whatever—then you have to do your homework and exercise judgment about what is good enough. It is not just a matter of saying, “My opinion of what I need is good enough.” You don’t make scientific decisions based on just opinion when you can assemble some facts. What data rate do you need? Can you quantify why? Not all decisions, especially when they are about tradeoffs, can be quantified. You try to quantify as best you can, but in the end some decisions are so complex that it once again comes down to judgment.

Deal!

The ACE mission . . . was undertaken by the Goddard Space Flight Center and the NASA Headquarters Office of Space Science on a not-to-exceed-cost basis. They agreed that the total cost of ACE from start-on-execution through launch-plus-30-days would not exceed \$141.1 million (in real-year dollars). In addition, Goddard agreed to launch ACE no later than December, 1997.

Source: National Aeronautics and Space Administration, *Advanced Composition Explorer (ACE): Lessons Learned and Final Report* (Greenbelt, MD: NASA Goddard Space Flight Center, July 1998), p.10.

I never told people what we were going to do; together, we got there by listening to each other. One of the things that defines a successful team is that they listen to each other. And it works across the project. The scientists listen to the people at APL who are struggling to do something on the spacecraft, and APL listens to the scientists to have some idea of what the scientists are struggling with. That is all part of building a project team, not just a few decision makers talking to each other, but the people who are actually doing the work. Even if you think that the probability of ever having to de-scope your requirements is small, there are times when you have to be responsive and cooperative to the constraints of the project, and it starts by listening.

NINE

Compliments to the Chef

ALLAN FRANDBSEN

PAYLOAD MANAGER

CALIFORNIA INSTITUTE
OF TECHNOLOGY

When I accepted Dr. Stone's offer in 1990 to head up the ACE payload development, I handed off my responsibilities as Chief Engineer in NASA's Jet Propulsion Laboratory (JPL) science division and moved to an office at the California Institute of Technology (Caltech) campus.

Although Caltech is only seven miles from JPL, there is a noticeable cultural difference between the two institutions. From my vantage point, Caltech was the perfect place for a relatively small, low-cost (\$50 million) payload like ours to

Minimum Mission Success Criteria

ACE will be declared successful if at least 7 of the 10 measurements are achieved.

- 1) Composition of heavy nuclei in both the bulk solar wind and in several high-speed streams.
- 2) Composition of coronal mass ejection events over a one-year period.
- 3) Solar-wind-pick-up ions over a one-year period.
- 4) Composition of heavy nuclei in co-rotating interaction-region events over a one-year period.
- 5) Composition of heavy nuclei in energetic storm-particle events over a one-year period.
- 6) Composition of heavy nuclei in 10 solar-particle events, including 3 large events.
- 7) Composition of heavy nuclei in small-impulsive solar flares over a one-year period.
- 8) Isotopic composition of anomalous cosmic rays.
- 9) Abundances of radioactive clock isotopes in galactic cosmic rays.
- 10) Isotopic composition of the "primary" galactic cosmic ray elements from carbon to zinc.

Source: National Aeronautics and Space Administration, *Advanced Composition Explorer (ACE): Lessons Learned and Final Report* (Greenbelt, MD: NASA Goddard Space Flight Center, July 1998), p.12.

flourish. Short of choosing the wrong people or having inadequate resources, nothing will torpedo a project quicker, I think, than the wrong operating environment.

By virtue of his close association with JPL, Dr. Stone knew that JPL was where he could find the management and engineering skills needed to bolster his research team for implementing ACE. My core team was small, and that's how I wanted it. It was just myself and three others, plus an assistant for the administrative tasks. We were responsible for development of all nine of the science instruments, and for making sure that they remained on schedule and within our overall budget.

After setting up shop at the campus, the first step was to get Caltech under contract with the Explorers projects office at NASA Goddard. Once under contract, I began inquiries with various JPL organizations to find talented people with a flexible outlook on their job who, like me, could be loaned to the campus for the duration of ACE. I was looking for the right mix of talent and attitude, people who could flourish in a university environment. The timing was fortuitous because the project came along at a point when the upper management at JPL was yearning for closer working-level relationships with the campus. Nevertheless, not everyone liked what I had in mind.

No staffing arrangement exactly like what I was trying to put in place had been tried before. Even though JPL has extensive experience in managing space flight projects for NASA, ACE was selected as a university-led effort for which JPL had no programmatic responsibility. Consequently, there were some raised eyebrows and a good bit of administrative hand-wringing at JPL. But eventually, with proper attention to the various contractual requirements, suitable staffing agreements were reached between JPL and Caltech. Along the way and before everything was finalized, it was announced that Dr. Stone was to become the next JPL Director in 1991. At that point, the remaining resistance to the idea of enmeshing JPL people in a campus research group seemed to fade.

In searching for the right talent at JPL to staff the ACE project, I was concerned about getting people who were too imbued with the JPL way, too hidebound from big projects. After working on big projects for years and years, one can get to the point where you can't think any other way, and that's not what was required for this job. Flexibility was more important than sheer brain power, so I actually told supervisors that I was looking for people who were a little bit out of the mainstream.

I didn't want a person who would be afraid to deviate from plowing the furrow down the farmer's field. Some people want to be constrained to a harness and go in a familiar direction, often the one of least resistance. Their whole career has been about following the rules, and they feel comfortable doing that. Following rules is fine, but you have to know when the rules need to be bent, tailored, or even broken, especially on an R&D project designed and executed within a university environment where most rules were flexible and processes generally adaptable to circumstances. So I sought out people at JPL who could flourish in that kind of environment.

When I interviewed people, I wanted to hear excitement in their voices. The way I saw it, they were getting an opportunity to spread their wings and be innovative, which always entails some risk both to your own sense of competency and to the project. That's what I was looking for, not someone who was worrying, "Am I going to be second-guessed by my supervisor back at JPL, or am I going to be chastised by some oversight organization?"

Punishment for not adhering to the party line can be such a big part of some organizations. Under certain circumstances, it can be a necessary evil. To the extent possible, I was determined to make the ACE payload development a positive experience.

Once we were up and operating, and despite Don Margolies' reservations that I should have a bigger team, I became comfortable with our staffing level. I might have felt otherwise had it not been for the fact that Gerry Murphy, the systems engineer I recruited from JPL, had developed such a good rapport with the technical people at the Lab. It became perfectly clear to me that what he couldn't handle himself, he could quickly parcel out and find help.

This approach was not always welcomed by JPL managers, who understandably had other priorities and responsibilities. But as one might imagine, it was some of the more enlightened supervisors who had the top notch technical talent in their organization. They realized that the best people need to have ongoing challenges to hone their skills, and they needed to find satisfaction in the process. For these JPL technical specialists, being given a temporary task in support of ACE was both a new challenge, and a refreshing assignment in a new operating environment. To them it was like a rejuvenation tonic for their professional enthusiasm. It succeeded as long as their absence from JPL assignments could be worked around and the arrangement was mutually beneficial.

Gerry had the most remarkable knack for finding just the right person. When we brought someone over from JPL in this way, we would use that person for a week or two, or five or six, whatever was required, and put them on the payroll. One technical division manager at JPL once said to me, "You know, it looks to me as though you're using my division like a cafeteria."

"I am," I said. "It's a great buffet you've got here—my compliments to the chef."

In point of fact, I had been selectively tapping the spectrum of expertise within his division. We would use a little bit of a thermal analyst here, or the support of a structural dynamicist there, and so on. And the truth be told, it was very important to the ACE payload development that we were able to pick and choose technical support from the expertise buffet at JPL. I think it can be true for projects in general that success or failure can depend on a manager having the flexibility to tap an outside reservoir of talent. To do so requires an understanding that the arrangement needs to be mutually beneficial to all parties.

TEN

An Educational Experience, No Less

ALLAN FRANDBEN

PAYLOAD MANAGER

CALIFORNIA INSTITUTE OF TECHNOLOGY

It was roughly a \$50 million payload, of which \$10 million was for Co-Investigator work at government labs that Goddard funded directly; the other \$40 million was for Caltech to administer to the remaining Co-Investigators. Based on my earlier experience, \$50 million for a nine-instrument payload seemed like a tight fit. I had to swallow hard on those dollar figures. But after realizing we could do better in a university environment, and having succeeded in carving out generous additional mass and power allocations (so that money wouldn't be spent meeting those constraints), I proceeded to take on the job of managing the ACE payload development.

Five of the largest instruments were to be new designs, but three at least had some spaceflight heritage. One new instrument was based upon another stratospheric balloon instrument that had never before flown on a spacecraft. The rest of the payload was either refurbished spares from another program (with appropriate adaptations), or supposedly straightforward design copy extensions of what had been flown before. As far as I was concerned, there were no straightforward adaptations or extensions. It was certainly an education for me to realize the scientist's view of what we were about to embark upon, and how different it was from a project manager's view.

ELEVEN

Promotion in Motion

DR. EDWARD STONE

PRINCIPAL INVESTIGATOR

CALIFORNIA INSTITUTE OF TECHNOLOGY

About the time that I was interviewing Al in 1990, I had been asked to become Director of JPL. Obviously I would not be able to spend a lot of my time on ACE. I thought I could still be an effective PI. I was Project Scientist on Voyager on about 30 percent of my time. I seem to have learned how to do things on less than full time. One thing I had in my favor was that I never felt restricted to a 40-hour workweek.

Whether I would be able to continue as the ACE PI was not my decision, however. It was up to NASA Headquarters. I asked, "Do you want me to step down?"

The answer was, "No, we want you as PI," and that is the reason I wanted to establish a Payloads office. Al agreed that he could continue even if I wasn't going to be there all the time.

On a mission like ACE, the role of the Principal Investigator is most important in the beginning when you are initializing things, putting together the requirements, and making sure that once you start down this road you have the group in place to actually get there. Afterwards, my main job was to provide assessment and guidance. Fortunately, Al and his group, and the Goddard office as well, were there to follow up on a lot of my issues once we got the project going, so I didn't need to spend a lot of time in the project office.

TWELVE

"Girl Sat"

MARY CHIU

PROGRAM MANAGER FOR SPACECRAFT DEVELOPMENT

JOHNS HOPKINS APPLIED PHYSICS LABORATORY

Most of my efforts in the early stages of the project were geared toward carefully choosing the right teammates. It was a matter of going around to the group supervisors and lining up people, talking to them, getting a feel for how they approached a project, learning their ideas about working on a team, and seeing how this meshed with mine.

Many of the people I was interested in were still busy working on other projects, but that was fine in the early stages because we didn't have a lot to do. Most of the money was going to the instruments, the problem child on any mission. I needed to keep a core concept in place for the spacecraft and enough people on hand with expertise in different subsystem areas, in case the instrument teams needed to bounce issues back and forth. When you talk to lead engineers, they typically do not want to sit around and plan out day by day what they are going to do over the next five years. In order to get the enthusiasm that you're part of the mission, that sense of "we're all goal oriented and want to get this done," you have to make sure as a project manager that you turn people on at the right time.

Although my bias was toward youth, I knew that I needed a mix of experienced veterans as well. APL is a small organization in comparison to NASA, and many of our same leads get used over and over. I had been at APL for 15 years, and I used to joke that I was still on probation. A lot of people never got a chance to move into lead roles, but upper management had realized it was time to bring some new people along.

In some ways, my promotion to Program Manager on ACE was part of this experiment. I certainly didn't fit the mold of former APL Program Managers. For one thing, I was the first woman to head a major program. Because this was considered a historic change for the institution, I was intent on getting other women into lead positions, including the lead systems engineer, Judi von Mehlem. Around APL they referred to ACE as the "girl-sat." At least that was what they called it to our faces. Behind our backs, our project was more commonly known as the "bitch set."

Can she do the job? I suppose the question lingers until someone has proven herself. I had to learn to handle the challenges as they came up. I had to learn as much as anyone. For instance, one time there was a piece of hardware we needed fabricated, and it arrived late from the machine shop. Rather than make a stink about it, I let it go. When the same thing happened again, I went down to the machine shop and learned that they didn't think I was serious about delivery dates because I didn't throw a tantrum the first time. "Okay," I said. "Here's my tantrum." Everyone thought that was cute, until they saw I was serious.

We had a mentor structure at APL, which meant that a lot of people who had worked spacecraft missions for decades were available to help guide newcomers to the fold, like me. For example, I had a wonderful quality assurance engineer who had been around forever. In fact, he retired soon after ACE launched. He could just look at things and say, "You know, you really don't want to use this material in this situation," or "You've got to be careful with that fabrication process." Things he said of that nature saved us on many occasions.

On the other side of the equation, we had a guy who was an extraordinary young mechanical engineer. I didn't realize it at the time, but when we appointed him as lead he didn't even have his degree. At APL, that would have been unimaginable to an earlier generation. I didn't know him directly, but someone pointed him out to me, and so I talked with his group supervisor and then with him, and I knew right away that he was a winner. He exemplified the talent pool I was going after.

THIRTEEN

Hot Meetings

MARY CHIU

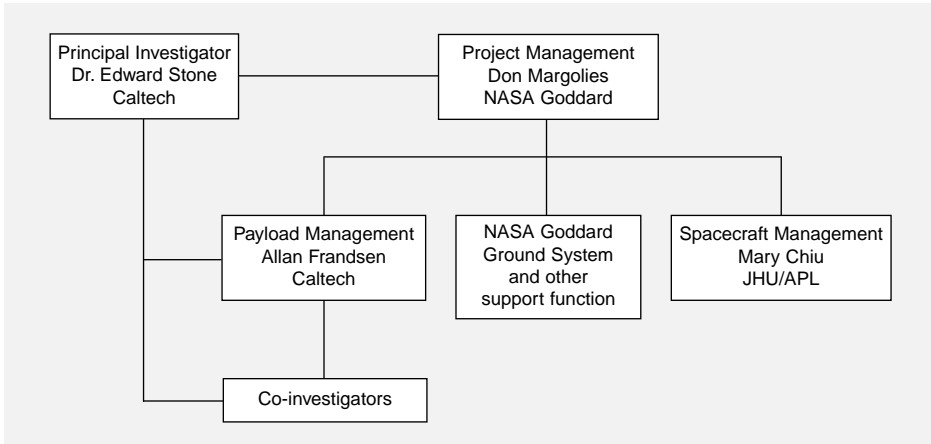
PROGRAM MANAGER FOR SPACECRAFT DEVELOPMENT

JOHNS HOPKINS APPLIED PHYSICS LABORATORY

A colleague walked by my office one time as I was conducting a meeting. There were about five or six members of my team present. The colleague, a man who had been with APL for many years, could not help eavesdropping. Later, he told me that it sounded as though we were having a raucous argument, and he wondered whether he should stand by the door in case things got out of hand and someone threw a punch. I laughed when he told me this, and at that point he looked even more puzzled. It was business as usual in there. "We were exchanging ideas," I tried to explain. He didn't get it.

That was not the way meetings in our organization were typically conducted. What distressed my colleague who stood outside the door was that he assumed that if people were raising their voices at each other they must be fighting. He didn't understand that there was enough trust and respect among the members of

ACE Organizational Structure



my team for us to feel that it was okay to express ourselves this way. We didn't think of ourselves as yelling at each other.

The loud volume reflected the comfort level that existed among us, and our passion. I'm not saying that passion can only be expressed this way. I'm saying this was a way that we expressed ours. The ACE team consisted of mostly young people, by APL's standards, and they were highly motivated, extremely intense, and dying for the opportunity to be part of something as exciting as a NASA mission. Our energy came into full flower at these meetings.

As for the tendency of team members to express themselves loudly, I not only condoned this behavior, I encouraged it. I said up front to everyone on the team, "Meetings are an occasion to voice your opinion and get your views on the table. We want to debate all points of view, and if that means raising your voice to be heard, then you have that permission." Volume was just a byproduct of having that many voices contributing to the discussion. It got loud because people felt that they had to raise their voice a notch—if not several notches—to be heard.

Because there were so many voices competing, it would be easy for an outsider to think our meetings were unstructured; but I always had an agenda which would be sent around before each meeting. Even if the meetings occurred impromptu, at the beginning I'd always say something to the effect of, "By the end of this meeting we need to do this."

Understand that we didn't maintain a fevered pitch throughout the entire meeting. Once we got all the ideas on the table, then we would sort through them in a more orderly fashion to determine how best to approach an issue. We tried to arrive at a consensus and were successful most of the time. Some people were not always happy with the final decision, and sometimes later they were proven right, but at the end of the meeting people accepted decisions and were willing to move on because the issue had been aired, with all points of view discussed.

Extended Phase B

Because of the Explorers Program funding shifts, the planned execution phase start for ACE was postponed. This allowed ACE to have an extended Phase B of around three years. . . . The exceptionally thorough nature of the Phase B effort by an experienced science team and APL spacecraft developer got the mission off to a good start.

Source: National Aeronautics and Space Administration, *Advanced Composition Explorer (ACE): Lessons Learned and Final Report* (Greenbelt, MD: NASA Goddard Space Flight Center, July 1998), p.28.

No one came back later and said, “Well, I had something to say that never got heard.”

When decisions have to be made, I believe people must speak up. Living with bad decisions is one thing, but I cannot live with a bad decision that was made because someone did not come forward with important information. Silence, as far as I’m concerned, is consent. My objective was just getting people to talk. Often we expect one person to be the leader in a meeting, and that’s usually the project manager, who is taking the pulse of the group and asking for input, but not really giving up the floor. A lot of times that person just gets what he or she wants.

It was remarkable to me how deeply people were thinking through situations and problems because they were expected to voice their opinions. With everyone expected to talk through an issue from his or her own point of view and assess the impact of what was up for consideration, I have no doubt that we steered clear of many wrong turns that could have been made on this project.

Borrowing a term from management psychology, our ACE team was a “hot group,” although we never thought of ourselves in those terms. The tenor of the discussion did get loud and volatile at times, but I prefer to think of it as animated, robust, or just plain collaborative.

FOURTEEN

The Sky is Blue, or Pink

DON MARGOLIES

PROJECT MANAGER

GODDARD SPACE FLIGHT CENTER

APL is a proud organization. If you ask them to describe the way they like to work under contract, they will tell you, “Give us the requirements, give us the money, and get out of the way and leave us alone.” Mary Chiu came into the proj-

ect with this classic APL attitude. In her shoes, I probably would have taken the same position. Most people would like to do their job and not have somebody looking over their shoulder. You certainly don't want to have someone second-guessing every decision you make. You want to be able to do your job, get it done, and get the results to your customer—and then have them say you did a great job and pay you for it.

But NASA's way of doing business is considerably different than APL's. We say to our contractors, "We'll give you the money, but we're not going to leave you alone. We expect to be partners with you."

For a while on ACE, tension existed between the two organizations. If Goddard said the sky was blue, APL would say it was pink. Fortunately, the distance between Goddard and APL is about 20 minutes by car. Let me tell you, when they talk about "location, location, location," they don't just mean real estate. Having that kind of proximity to each other made all the difference in the world toward cultivating a partnership between our organizations.

Tips on How to Lead Productive "Hot Meetings"

- 1) Limit the number of attendees. Hot meetings generate a comfortable amount of heat for me when the number of attendees is small—five to seven people. With too many people there, you risk creating too much noise. Also, my meetings tend to be the most productive when the attendees represent complementary disciplines.
- 2) Spontaneity should be a high priority. Yes, you want to have an agenda, and certainly you may feel that you need to accomplish something specific by the end, but at the same time be open to letting the meeting unfold naturally out of the discussion.
- 3) Listening is important. Encourage everyone at the meeting to listen to what other people are saying. You want people to examine their own ideas as they hear others express theirs.
- 4) For hot meetings to be effective, the group must function as a cohesive team who trust one another and share a belief that they are mutually responsible for project results. A group of people who don't feel dependent upon each other is a committee, not a team.

Source: Mary Chiu, "Hot Meetings," *ASK Magazine*, Issue 7, NASA Academy of Program and Project Leadership, March 2002, p. 36.

I held staff meetings at Goddard every week; Mary was always invited, and she attended most weeks. I also held monthly meetings at APL, and I brought my Goddard team with me. Each of Mary's subsystem leads stood up and gave a status report on his or her subsystem. People weren't afraid to say what was happening, and people weren't afraid to make a mistake because they understood that no one would get shot for making mistakes. Our working philosophy was: You find a mistake, you fix the mistake, and you move on.

My staff would then get up and talk about the status of the instruments, ground system development, and so forth. I don't know how to put the value of that into dollars and cents, but I can't think of anything we did on the project that was more valuable than these meetings.

I'm not sure that the relationship between APL and Goddard, between Mary and myself even, was ever 100 percent harmonious—but then, is that what you want, total harmony? A little friction is good for a project. We at least reached a point where she believed that when I said something she could take it to the bank, and I believed that when she told me something I could make a deposit as well.

My being able to get out to APL in a few minutes and Mary coming over to Goddard went a long way towards establishing a trustful relationship.

FIFTEEN

Keeping It Simple, Not

MARY CHIU

PROGRAM MANAGER FOR SPACECRAFT DEVELOPMENT

JOHNS HOPKINS APPLIED PHYSICS LABORATORY

ACE was supposed to be a simple spacecraft, and that's why we decided on a simple data handling system. Early on in the project, my lead engineer on the data handling system worked this out with Dr. Stone. In fact, it was Dr. Stone's decision to go with this type of system. At one of the reviews, my engineer thought he had gotten closure on the issue, "This is the most simplified approach, and this will be the most straightforward system to develop and test. Is this the way you want to go?"

Dr. Stone said, "Keep it simple." In fact, that became our mantra when dealing with this issue, "Keep it simple."

We thought everything was settled, until some people at Goddard suggested that we use a different data handling format. With all the really neat things being done on other spacecraft, they asked, why were we getting this "old fashioned" data handling system? For my team at APL, the people building the spacecraft, this was no small matter. To change to a different data handling system would have required a major restructuring of the spacecraft's design. At the time this issue

came up in 1994, we were already proceeding along with fabrication, and major changes of this sort couldn't be taken lightly.

But when NASA wants to know why you can't do something, the last thing you want to do is ignore them. I got my leads together to formulate our position, and I responded by writing a paper, explaining the ramifications of such a change. Well, that wasn't good enough, apparently. What they sent back to us was what we already knew. Newer data handling systems provided reprogramability, meaning that if one instrument shut down you could send more data to the other instruments, and isn't that a good thing? Yes, of course it is; but the point I had to keep coming back to, the crux of the issue as far as I was concerned, was that we had not intended the system to be reprogrammable. We went round and round about that, and there was quite a bit of paper exchange.

"Okay," I said at last, "if you want to give us a change order, fine, I'll give you the impact statement, and it will be in cost and schedule. If you still want to change from what was agreed on, that's fine, too," but I made clear that they couldn't change requirements this radically and still maintain the original schedule.

There were several comments intimating that the people on my team were not a "can-do" group, and that upset many of us. Like any highly motivated team, we took pride in our work. I worked to make sure none of this unpleasantness escalated into something that might have had a corrosive effect on our relationship with the project office. I spent time coaching people on how they should behave, "Okay, you're professionals and we know you're good at what you do," I told them. "These are our customers, and we have to always be courteous. You still have to make yourself available to them. They will be here talking to our people. Questions get asked, and that's only natural, but if questions start sounding more like directives, or, Why don't you do this? and, Why don't you do that? very politely say, 'Well, that's an interesting idea, but let's bring Mary into this and discuss it at the project level.'"

Naturally, you want to have open communication with the customer, but sometimes you have to be careful in what you say because you're speaking not just for yourself but for APL. Overall, I think the team, including myself, became a lot better at approaching communications. What we did, as time went by, was to not just say, "No," but "No, because if you do this it will impact this, this, and this." Once you explain it, rather than just saying no, you're not as likely to hear them come back to you with "What do you mean you can't do that? It seems like such an easy change to me." Yes, there were some awkward situations, but the team did a fabulous job of addressing customer concerns.

The flap about the data handling system passed quickly enough. We ended up sticking with the original system, and while a few of us may have been left with a bitter aftertaste, overall we at APL probably came out stronger as a team because it allowed us to refine our communications strategy with our customer.

SIXTEEN

Brown Envelopes

JOHN THURBER

OBSERVATORY MANAGER

GODDARD SPACE FLIGHT CENTER

As the Observatory Manager for the Goddard project office, I needed to have a good rapport with Mary Chiu and her team because I was the primary interface between Goddard and APL. In the end, I believe we had a good relationship, but it took a long time, as I think it does for most people who are coming into APL from outside.

Early in the program, while I was visiting APL, I took an opportunity to visit some of the subsystem leads. Mary Chiu did not want me talking to her leads without her being there, and when she found out I had done that she got very upset. Next time I went out there my visitor's badge had been pulled. There was no problem getting me reinstated, but it sent a strong message as to how she ran her program. It was a good six months later before I felt I could say, "Hi Mary. How are you doing? Let's go have a cup of coffee."

One of the turning points, ironically, came during what I think of as the most contentious period in our relationship. I was looking for more detailed accounting data than we were getting from the standard government form that contractors have to fill out each month. The project office wanted a work breakdown structure to a level where we could tell how much money subsystems had spent.

One of the things I was concerned about was that APL had recently lost a large contract with the Navy, and I noticed that new people were jumping onto ACE, presumably charging to the project. Mary assured me that wasn't the case, but I

Saving Costs

The design of the NEAR spacecraft was concurrent with ACE. The two C&DH subsystems were designed with as much commonality as possible. This allowed the design costs of many boards to be split between the two programs. . . . In terms of fabrication, the chassis design of the C&DH component reduced costs compared to earlier programs by milling the chassis out of a single block of metal, instead of individually milling out each side and assembling the sides together. This minimized the number of drawings required and minimized concerns about tolerances and error buildup in assembly.

Source: National Aeronautics and Space Administration, *Advanced Composition Explorer (ACE): Lessons Learned and Final Report* (Greenbelt, MD: NASA Goddard Space Flight Center, July 1998), p.86.

didn't know that, and the accounting sheets we were getting didn't provide specific enough information to verify it.

I talked to a subsystem lead and he assured me, "Oh yeah, we are the only guys working on this," but I knew that if I started to ask probing questions, the first thing he would do was go back and say, "Hey Mary, Thurber was down here asking questions about who was charging to the contract." And then Mary would come down and say, "If you want to know who is charging, come see me."

I asked her for more detailed accounting data, and she kept saying, "It's going to cost me more money on the contract if I have to go to a special accounting system." We went around about that for a few turns, and then, finally, I gave up asking and told her to charge it. I wrote the amendment to the contract, I ran it through the contracts office at NASA, through Legal and back to APL.

To my surprise, instead of signing it, she just handed me a brown envelope and said, "Here are my internal sheets. Why don't I just give them to you? Is this adequate?" I looked them over, and they had everything I needed. "This works," I said.

Every month I got a brown envelope from her, and everything worked out fine. I got what I needed, and she never caught any grief from me about who was charging to the program. After that, we developed a much better rapport, and we never had another issue with a contract modification.

SEVENTEEN

Project Management: Easy as ABC

ALLAN FRANSEN

PAYLOAD MANAGER

CALIFORNIA INSTITUTE OF TECHNOLOGY

During my interview when I was applying for the job of Payload Manager on ACE, Dr. Stone said, "Al, give me an idea of your management style."

It was a question that I had not considered before. I thought about it for a few seconds and then answered, "Well, the first descriptive term that comes to mind is the word 'tranquility.'"

Well, ironically enough, that seemed to startle him. So I added, "I guess what I mean is that if the situation is tranquil and the project is running smoothly, then I've anticipated all the problems and taken necessary actions to head them off."

He then asked, "Have you ever reached this state?"

"No," I admitted, "but I strive for it."

Tranquility is probably an overstatement, but in running a project, I have always tried to anticipate problems. To lead a project effectively, one has to establish and maintain the flexibility to take appropriate actions when needed.

To get on top of matters and stay there, a manager needs to anticipate what it will take to successfully complete the job. Physical and financial resources, person-

nel, and management structure are all important considerations. Carving out the necessary turf up front can make a world of difference to the project's outcome. After the what, where, and when of a project are nailed down, the next question is how to do the job.

I once told Dr. Stone that if I had to write down the ABCs of project management, "A" would signify anticipation. But it is not just a planning activity that needs to take place at the beginning. It is also an ongoing thought process that reviews plans over various time intervals. A manager needs to work all the time to avoid losing control of events and operating only in the reactive mode. "Putting out forest fires," being "under the gun," or "behind the 8-ball," are expressions that we are all familiar with. To avoid being in one of these situations, there needs to be a frequent assessment of the current status, and some reflective thinking about what could happen next.

Of course a good project manager already knows, at least in general terms, what is supposed to happen next—but all too often it doesn't. So what are the alternatives? Are there sensible work-arounds? What can I do now to lay the groundwork or facilitate matters should something go wrong? These and other questions make up the ongoing process of anticipation. And because it is an ongoing process, the "A" in the ABCs of project management could just as well stand for "anticipate . . . anticipate . . . anticipate."

One of the important activities at the start of any project is identifying and recruiting the staff necessary to do the job. One should always try to sign up the best mutually compatible talent available. In this process, and until charisma transplants become available, it helps if the manager is inherently excited about the project. Exuding enthusiasm can become contagious, and it goes a long way toward recruiting the best people. With the right team in place, the manager's job is likely to have fewer day-to-day problems, as well as being less stressful than it otherwise would have been. Hence, it is well worth the effort up front to carve out the time and generate the enthusiasm to build a good team, the "B" in the ABCs of project management.

Once a project is up and running, a manager needs to establish and monitor channels of information flow. The manager needs to foster communications between and among participants. You certainly don't want to hear of a problem being excused by such statements as "I didn't know I was supposed to . . .," or "I didn't know that what he was doing was incompatible with . . .," etc. And of course there are always peers as well as upper management who need to be apprised of what is going on.

In the absence of sufficient information, they could well form a wrong opinion of the current state of affairs, or worse yet, undertake counter productive actions based on invalid conclusions. A busy manager doesn't need any counter-productive "help" by well-intended colleagues. So the best defense is a good offense. Take the time to communicate upwards, downwards, and sideways. Communicating is the "C" in the ABCs of project management.

Now there is also an “s” at the end of the ABCs of project management. Does that have any significance?

Well, I would say that despite your best-laid plans and ongoing attention to the job, the situation can turn to manure in a hurry if a personnel matter arises. So sustaining this prized team you have recruited has to be an important part of a manager’s job as well. Sustaining the team includes recognizing their accomplishments, and arranging the job so that they find it satisfying. Conversely, a heavy-handed management style can be the death-knell to a team member’s feeling of personal responsibility for success.

On projects that require people to exhibit resourcefulness and innovation, people need to be given not only the responsibility but also the authority to spread their wings. Constructive criticism may be called for at times, but that is different from punishment. In short, and for research and development in particular, ongoing attention needs to be paid to supporting the team. “Sustain the team” concludes the ABCs of project management.

EIGHTEEN

Tranquility Will Work for Me

DR. EDWARD STONE

PRINCIPAL INVESTIGATOR

CALIFORNIA INSTITUTE OF TECHNOLOGY

Al showed remarkably good judgment in dealing with the instrument teams. The thing was not to try and oversee what they were doing. These were all people who had built instruments before. They weren’t going to pay attention to somebody telling them to do things they knew were unnecessary. Having dealt with NASA before, their tendency right away was to think that someone coming from JPL would try to oversee what they were doing, demand a lot of paperwork, proscribe rules to be followed, and expect things done a certain way. Obviously that wasn’t Al’s style.

The way Al ran the payload office was to try and be helpful to the instrument teams; and that’s how I interpreted what he said about his management style being one that strived for tranquility. I wouldn’t have used those terms myself, but what it indicated to me was that he wanted to work with people rather than direct them, and that gave me the confidence I needed when I moved from Caltech to JPL to become director at the Lab.

NINETEEN

A Gentle Touch

ALLAN FRANDBEN

PAYLOAD MANAGER

CALIFORNIA INSTITUTE OF TECHNOLOGY

One aspect of my job as Payload Manager involved keeping track of what the different science teams were working on and offering help where it was needed. At first it seemed as though many of the scientists, or their technical staff, weren't certain how safe it was to confide in me. Everybody knew I had spent most of my career with NASA at JPL. All of my staff, the four of them, also came from JPL. Left to our own devices, would we impose onerous NASA rules that could stifle innovation in the instrument development labs?

The challenge to my team was getting these science groups to regard us as partners, or as people who could help them, rather than what they seemed to expect us to be—a troop of requirements enforcers. There were 9 instruments and 20 Co-Investigators (Co-I's) on ACE. They were scattered at universities and a few government labs across the United States, in addition to labs in Switzerland and Germany.

At one university in particular, a designer held things very close to his chest. At first, we could barely get him to acknowledge that we were in the room with him, until we arranged to help him solve a power supply problem. His boss, a Co-I, recognized the contribution we had made, and figured that we might be able to help solve a sensor-head problem as well. There was no pressure; we waited for him to approach us—and when he did, we didn't press him to let us get more involved. It was that kind of gentle touch that eventually changed peoples' perceptions about our role on the project.

From the start, I decided that this gentle touch was the best approach. Dr. Stone had assembled experienced Co-I's for each of the nine instruments. I knew of the strong relationships that existed before I got there and would continue after I left. I never tried to put myself between Dr. Stone and his science teams. I wasn't about to say to a Co-I, "You can't report to Dr. Stone—you've got to report to me first, and I'll report to him." That would be dumb, I thought, and certainly do little to improve our standing at their labs.

A lot of it just came down to working hard with the Co-I's at solving development problems, and building their trust in the process. When you spend days and nights with people, and you suffer with them, they begin to realize that you're on the same team. At the same time, they knew we could bring precious outside resources to bear in addressing special problems.

I enjoyed telling people about how my payload team adapted the spirit, if not the letter, of NASA practices to fit the university environment. Understand, we still had to meet our requirements and satisfy the Goddard project office. In the reliability and quality assurance (R&QA) area, for instance, we were expected to

audit work processes used at the contractor's site. In this case, that frequently meant a trip to the university labs. Well, the word "audit" can put a terrified look in people's faces; but we tried to perform the audits using a low-key approach.

I can recall my visiting R&QA manager walking down the hall at one university with his arm over a technician's shoulder, asking, "How's it going? What's happening here?" All the time, that technician never realized that this was part of a work-process audit. Again, a gentle touch paid off by keeping everyone working together toward the same goal: delivery of a performing payload, on time, and within budget.

TWENTY

To Communicate—Or Not to Communicate

ALLAN FRANSEN

PAYLOAD MANAGER

CALIFORNIA INSTITUTE OF TECHNOLOGY

Contrast that with other occasions when we would walk into a development lab and talk to a person at one bench who had no idea what the person at the next bench was doing. Ignorance is not always bliss. Instead, it usually leads to interface problems, or worse.

Communication varied widely among the science teams developing the ACE instruments. At one university, the Co-Investigator wrote down some of the topics for the day on a whiteboard in the hall for everyone in his lab to see. Every person involved had to add a few words about what they were going to do that day and who they were counting on. It was amazing how much communication that fostered.

TWENTY-ONE

Implementation Reviews

GERALD MURPHY

PAYLOAD SYSTEMS ENGINEER

CALIFORNIA INSTITUTE OF TECHNOLOGY

The biggest challenge in managing science instrument development (or any new technology development for that matter) is trying to get the project completed on schedule for the money you have. Few project managers accomplish that, despite what they might tell you.

It just doesn't happen, and it's easy to understand why—technology development doesn't have a predictable path. You haven't built this thing before, so how the heck do you know how much it's going to cost? And besides, you can't foresee all the problems you'll run up against. You know the result you want, and you declare success when you are "close enough." In short, the job must be dynamically managed.

On ACE, we needed to produce five instruments that were either entirely new or considerably modified from earlier models. Each would cost several million dollars to build, and they were all what I would call “technically risky” in one way or another—some in several ways.

Some of our problems early in the project derived from not understanding exactly what the instruments were intended to do (what was going to be “good enough”), and not knowing what we could do to help the university teams build them. We in the payload management office took the approach of asking each team, “What do you need in order to get your job done, and how can we make that happen?”

To address these concerns, we decided to have implementation reviews. I had never been on a project before where this was done, but it turned out to be the single most valuable review we had from the point of project success. Typically, reviews are design-focused. In point of fact, many of a project’s problems are not caused by design flaws—they are caused by implementation flaws. In our case, even if an instrument had a good “design,” its implementation needed to be executed smoothly.

When I use the word “implementation,” I mean it in the broadest sense: implementation of the design and manufacture of the instrument. And I don’t just mean taking a look at schedules and money. I also mean looking to see if you have the right team, a team that is assembled in such a way that the lines of responsibility make sense, and interfaces that are clear and easily defined.

Do you have margin for error? Where are the technical risk items, and what is your plan to deal with them? Who is responsible for what? How many engineers do you have on this job, and do they have the right experience?

So, you have five engineers? Well, I only see three engineers in the room. Where are the other two?

“Well, they actually work for Joe Blow, a scientist down the hall. Joe has promised me that a year from now, when I need the engineers, I can have them.”

Yeah, right, but what happens if Joe decides he needs them in a year? They actually work for him, right?

For the ACE payload, we traveled around to each instrument developer. The process was labor intensive because we camped out onsite for three days. We sat around the table together, listened to presentations, and figured out how we were going to get the instrument built and delivered. We found the holes and looked for ways—together—to plug them. We tried not to be optimistic and fool ourselves.

The size and composition of review teams were tailored to the places we went. Review teams turned out to be between five and eight people, a balance across the different disciplines, and they included the payload group (i.e., Al Frandsen, our R&QA manager, and me). It was always tricky putting together just the right team, but Al Frandsen, our payload manager, was good at that, and we managed to find the expertise that we needed. For example, let’s say that we knew a team was having a problem making their detector meet launch load requirements. We

would grab somebody from JPL who could solve that in a week instead of letting the instrument team spin their wheels for six months. In addition, we would typically bring people from Goddard who were good at understanding resources and estimating actual costs.

The point of the implementation review is to prevent problems from occurring later by trying to get our arms around the planning from the start. The implementation review happened only once at each site, but it was a big deal. If it occurs too early, it's not beneficial; if it's too late, you're already buried in trying to solve the problems of the day instead of being ahead of the wave.

Implementation reviews do one other thing: they set the tone for the management of the project, thereby establishing a teaming relationship (if they are run right), and leveling the playing field instead of setting up turf wars.

TWENTY-TWO

Small Wins Make for Big Gains

FRANK SNOW

GROUND SYSTEM AND FLIGHT OPERATIONS MANAGER

GODDARD SPACE FLIGHT CENTER

It occurred to me that the Flight Operations team, which I managed, should get involved in the data analysis after launch, something that was usually the sole responsibility of the science teams. My Flight Ops team knew the ground system we were using inside and out, and I thought that they should, at the very least, train the people out at Caltech on how to use it. So I offered our help.

One of the Co-Investigators at Caltech, however, was terribly suspicious of the Goddard project office. Almost any help we offered to make his life easier was, he believed, a ruse to take control of his instrument. As appreciation for my offer, he sent me a blistering email that basically said, in 300 words no less, "Hell no!" At that point, I decided to fly across the country to Caltech to talk with him. Maybe I'd have better luck in a face-to-face meeting.

I went there and listened to his concerns, I empathized with him, and then assured him that no one in the project office was trying to take anything away from him or from Caltech. In fact, we were actually interested in expanding Caltech's responsibilities, if they wanted this, to include flight operations. Moreover, I told him that I would put it into the operational plan to move the operations, i.e. the total operations of the spacecraft, over to Caltech after launch. As far as I know, they never took us up on that, but when I made the offer a couple of years prior to launch this was definitely something that he and the other Co-Investigators found interesting.

He never formally acknowledged it, but I think he saw that what we were offering was not such a bad idea after all. He allowed the Flight Ops team to come to Caltech and provide training in the ground system. They went out there and

ACE Scientific Team

Principal Investigator

Edward Stone—Caltech/JPL

Project Scientist

Jonathan Ormes—NASA/GSFC

Co-Investigators

Robert Binns—Washington University

Peter Bochler—University of Bern, Switzerland

Leonard Burlaga—NASA/GSFC

Alan Cummings—Caltech

William Feldman—Los Alamos National Laboratory

Thomas Garrard (deceased)—Caltech

Johannes Geiss—University of Bern, Switzerland

George Gloeckler—University of Maryland

Robert Gold—JHU/APL

Dieter Hovestadt—Max Planck Institute for Extraterrestrial Physics, Germany

Berndt Klecker—Max Planck Institute for Extraterrestrial Physics, Germany

Stamatios Krimigis—JHU/APL

Glenn Mason—University of Maryland

David McComas—Los Alamos National Laboratory

Richard Mewaldt—Caltech

Eberhard Moebius—University of New Hampshire

Norman Ness—University of Delaware

John Simpson—University of Chicago

Tycho von Rosenvinge—NASA/GSFC

Mark Wiedenbeck—JPL

Source: California Institute of Technology/ACE Science Center, accessed at http://www.srl.caltech.edu/ACE/ace_personnel.html on 15 June 2003.

helped him. We made it clear that we were willing to send them at the drop of a hat. Whenever he asked for help, we sent someone immediately. I think he found the Flight Ops team to be a lot brighter than he had expected. All the team members had degrees, most in engineering. What he expected, I think, was a bunch of desk jockeys who couldn't do much more than look at screens.

Clearly, face-to-face communication went a long way towards dispelling his suspicions about my intentions. I don't recall after this ever getting another 300-word email from him of the "no-thank-you-and-please-go-away" variety. As a matter of fact, I think I could even say that this was the beginning of a fruitful relationship that lasted for the rest of the project.

TWENTY-THREE

Differences

ALLAN FRANDBEN

PAYLOAD MANAGER

CALIFORNIA INSTITUTE OF TECHNOLOGY

Win, lose, or draw—those are the most likely outcomes in trying to resolve differences among project participants. A draw occurs when a solution is found that not everyone is happy with, but all can live with.

Then there is the matter of winning or losing. The project office at Goddard and the payload office at Caltech had differences from time to time over management issues. An early one was over the need for a detailed Work Breakdown Structure (WBS). Creating one was a contractual requirement placed on Caltech. I didn't object to charting the relationships between pieces of the job, but I felt it unrealistic to go to the level of detail required by the Goddard reviewer. It might have been appropriate on a large project, but it wasn't for our modest-sized one. When my arguments went nowhere, I conceded. In order to satisfy Goddard's appetite, I knuckled down and generated an inch-thick document describing what went on in each work element of the payload development. To me it was of no value, but one has to decide what battles are worth fighting, and I needed to get on with more important work.

One alternative to granting a concession is to hold one's ground and suffer the slings and arrows of criticism. Such was the case when I came under criticism from Goddard for spending payload reserve funds early in the program. Their feeling was that at the rate the funds were being used, the money would run out even before instrument environmental testing began. I countered that I was mindful of the need to maintain reserves in case failures occurred during the test program, but that judicious use of reserves early on was important.

At one point, we had three separate efforts under way to solve a sensor development problem with one of the heritage instruments. It was supposed to be a "design copy" of one launched on an earlier mission. We knew that we would need to design and build an electronics box to adapt it to the ACE spacecraft data system. But more urgently, data from the earlier mission showed that the sensor design itself was inadequate for the task. I kept our three development efforts going simultaneously, but on a short leash, until a fix was found. The early use of reserves made this possible.

I believed in my judgment on this matter, stood my ground, and was stubborn over my prerogative to control the reserves given me. Yes, we worked on a lot of different solutions that didn't pan out. Still, you had to try because at the time they all seemed like they might pan out. Once a problem was solved to the "good enough" point, we stopped and moved on to the next problem.

I always advocate spending reserves early to solve problems. I know we went through the reserves quickly, but I believe the early use of reserves was an impor-

tant part of how we caught problems on the payload side of ACE. The longer you let a problem go, the worse it gets, and the more it costs to solve later down the road. As soon as I got a whiff of a problem on ACE, I swiftly mobilized technical resources to solve it.

TWENTY-FOUR

Class Management

DON MARGOLIES

PROJECT MANAGER

GODDARD SPACE FLIGHT CENTER

As we were defining the de-scopes on the payload side, we looked at each and every instrument and its capability—we found considerable overlap in terms of the capability of many instruments. We found that instrument A, in some part of what it was attempting to do, overlapped instrument B, and we found the same sort of thing for many of the others. We said: all right, starting from scratch, what would be the impact if any single instrument failed? Is there another instrument that can provide similar data? What if two of them failed in different combinations? Realizing the amount of redundancy we had, it looked to me like we could tolerate some failures in the payload and still have a successful mission.

ACE was classified as a C mission. Back then, NASA classified missions in terms of A, B, C, and D. Class-A missions would be something like the Space Shuttle. If it failed, it would be a national catastrophe, and NASA would be embarrassed to tears. On Class-A missions, you did everything you had to do to make it 100 percent reliable. Class-B missions had a slightly lower profile, and risk was a little more acceptable. Class C was a less expensive mission to begin with—you could afford more risks, and if it failed, the country wouldn't go into hysterics. A Class-D mission would be something like a small satellite rocket—reliable and cheap, so get it out the door as fast as you can. With all this redundancy in our instrument suite, I started to think that maybe we could get away with dual-classifying ourselves.

ACE was a cost-capped mission now. I had hammered out an agreement with NASA Headquarters for a specific dollar figure, and the last thing I wanted was to go back to Headquarters and say we had blown our budget because we had to add staffing to one of the instrument teams.

“We aimed to set a new paradigm with the ACE Flight Ops team: a team that had experience with the integration and testing of the spacecraft and instruments. In this way, they would be prepared for all spacecraft emergencies, and also provide the other groups of the Mission Operations team [with] a knowledgeable user-friendly interface to the orbiting spacecraft.”

—Frank Snow

When you translate Class C down to instruments, it still represents a significant burden. For example, if I gave one of the instrument teams a requirement on quality assurance to build circuit boards, I had to know how they tested parts, and who was certified. There would be a good many requirements, and a lot of these requirements involved reports—enough paper to fill up an office somewhere. Some of these instrument teams, especially at the universities, didn't have a clue how to meet some of these requirements.

If we could get away with flying a set of Class-D instruments, this would simplify the job tremendously for the universities, and for Al Frandsen in trying to get their payloads built. Could we go to a lower level of reliability testing, for example, and still meet the ultimate mission requirements? We determined that the answer was yes.

Headquarters agreed. They looked at all the redundancy and said, yes, it made sense to dual classify ourselves. You may fly a Class-D instrument suite on this Class-C spacecraft.

Instrument Requirements for Each Measurement to Meet Minimum Success Criteria

Instr Meas	C R I S	S I S	U L E I S	S E P I C A	S W I M S	S W I C S	E P A M	S W E P A M	M A G
a)					1	1			+
b)					1	1			+
c)					+	1			+
d)		+	2	2	2	+	+	+	+
e)		+	2	2	2	+	+	+	+
f)	+	2	2	2	+	+	+	+	+
g)	+	+	1	1	+	+	+	+	+
h)	+	1	1						
i)	1	1							
j)	1	1							

1 – One of these instruments must work for a successful measurement
 2 – Two of these instruments must work for a successful measurement
 + – Significant supporting measurement

Source: National Aeronautics and Space Administration, *Advanced Composition Explorer (ACE): Lessons Learned and Final Report*, (Washington, DC: NASA Goddard Space Flight Center, July 1998), p. 21.

TWENTY-FIVE

Something Else

DON MARGOLIES

PROJECT MANAGER

GODDARD SPACE FLIGHT CENTER

On a project like ACE, there may be many systems engineers, but there is generally one who sits on the top—the Mission Systems Engineer. You look to that person to lead the overall systems engineering effort. NASA civil servants typically provide this systems engineering oversight on all of our projects.

I had an engineer working for me at Goddard who really didn't have the experience to be a Mission Systems Engineer. For several months, I tried to find ways to bring him along. Finally, I had to accept that it wasn't going to work out. I had two options: replace him with another Missions System Engineer from Goddard, or something else—so I chose something else.

On ACE, we had an outstanding systems engineer at APL in Judi von Mehlem, and she coordinated well with the systems engineer at Caltech, Gerry Murphy, also an outstanding systems engineer. I decided to use the APL systems engineer as my de facto Mission Systems Engineer. We said, "Judi is going to do all the things that you would expect your Mission Systems Engineer to do, and she will coordinate with Gerry Murphy and make sure we get the job done right." It wasn't assigned officially, and we didn't change any contracts.

The amount of supervision or direction my guy was providing was minuscule, so we just let Judy do the things she needed to do and was doing anyhow, and Gerry did the stuff he needed to do and was doing anyhow. My systems engineer served as the primary interface with the launch vehicle contractor—which put him in a position I thought was appropriate for him. He still retained the title of Mission Systems Engineer, but he was doing something else, something that he did well, and he was okay with that.

I had an organization chart that showed a Mission Systems Engineer. It was nobody's business but mine that he was filling a different role. Yes, it was a bit awkward without the Goddard oversight, but I was comfortable using that arrangement. I was never out of the loop, my people were never out of the loop, and we were able to do the systems engineering work that needed to be done.

Once I became convinced that Judi was top notch, and once I got to know Gerry Murphy and saw that they worked well together, and, best of all, that they required very little oversight, I understood that I had the "something else" I needed.

TWENTY-SIX

Common Ground

GERALD MURPHY

PAYLOAD SYSTEMS ENGINEER

CALIFORNIA INSTITUTE OF TECHNOLOGY

Being the systems engineer for payload was nothing like Judi von Mehlem's job on the spacecraft side. At APL Judy could say, "Okay, everybody has to test hardware to 12.5 g's," but I had to tailor specifications to each of the instruments. Each university or institution where an instrument came from had a different culture, and each had its own way of doing things. It was close to impossible to get uniform compliance across all of the subsystems.

Initially, Judi and I tried to pretend our differences didn't exist or that they would magically go away, but there were a number of times where our differences came to a head. Vibration specification was a good example. APL had a specification that they wanted us to use to qualify all instrument boxes. "Since you are riding on our spacecraft, then you have to meet our specification," they said.

APL's specification was based on their institutional precedents, which we felt were overly conservative in the area of vibration test levels. Our environmental test program for the payload was an amalgam of the best we knew about from various other institutions and projects. It was less conservative, and—we thought—more appropriate. We knew how delicate the payload sensors were, so we specified a lower vibration test to avoid damage. "Well, you don't really have to worry about the payload," we said, but they thought they did. ACE was my first experience finding culture differences between institutions that actually manifested themselves into heated differences of opinion at the engineering level.

Goddard had to intervene. They told Judi, "You don't have to worry about the payload. If something in the payload breaks, it's not going to be your fault; it is payload's fault, and they have to deal with it."

Judi and I are both headstrong and intelligent—and used to winning arguments. I have to say, our relationship started rocky. Here we were, two equals sort of battling each other. I think it took us the better part of the first year to realize that this was dumb. We had to ask, "Why are we battling each other when we're both trying to get the job done?" We found a way to talk through things and resolve our differences, largely because we kept talking and trying to understand each other's point of view. I'm making this sound easy—it wasn't.

Judi and I worked hard at building good communication. It took a while to understand one another's point of view, and what we needed to do to work through that. For me, earning Judy's respect on technical issues became a challenge that I found motivating. On numerous occasions she challenged my opinions, and I had to go back and sharpen my pencil and come back with a better technical argument. In the example I used before with the vibration specifica-

tions, where APL wanted to do it one way and we wanted to do it another, I had to come up with sound technical reasoning.

ACE challenged me intellectually, but this is also what made the project so rewarding. What I think we learned was this: the fact that I did things this way, and Judy did them that way, and Goddard did them yet another way did not mean that any of our ways was the one true way. Even though we might argue about things and agree to disagree, we earned one another's respect, and we didn't make our differences personal.

TWENTY-SEVEN

Engineering By Walking Around

JUDI VON MEHLEM

SPACECRAFT SYSTEMS ENGINEER

JOHNS HOPKINS APPLIED PHYSICS LABORATORY

A lot of people don't understand the management component that comes with being a systems engineer. They think of it entirely as a technical role, but it requires a good deal of communication skill. The systems engineer looks at things from all angles, often without a lot of data on hand. For example, subsystem A, Mechanical, wants to do one thing, and subsystem B, let's call it Electrical, wants to do another, and you obviously cannot do both.

Systems engineering, I've come to see, is a two-way street. The people I worked with at APL kept me informed. I always knew what the problems were. I always knew when to become more involved. For example, we wanted to get a pulse on one of the instruments for the observatory. One of our leads had good ideas about how to do that, and he and his group went off and started working on it. I stayed on top of what they were doing. I didn't get into the nitty-gritty details, but I spoke with the lead continuously. Whenever I saw him in the hall, or when I walked by his office, I asked how things were going.

A good systems engineer doesn't sit in her office and conduct business from afar. At the same time, when she knows that she has good people working on a problem, she gets out of their way. I think that's how it works on most successful programs.

TWENTY-EIGHT

Psychology Lesson

DON MARGOLIES

OBSERVATORY MANAGER

GODDARD SPACE FLIGHT CENTER

APL fell behind schedule as we were approaching our integration and test phase. We not only had to integrate the spacecraft and test it, we had nine instruments coming in. It looked to me as though there was only one of two ways to pick up the slack: put some people on double shifts, or work on the weekends. Neither was an attractive alternative, but we had a lot to do and the work had to get done.

I asked Mary Chiu to choose option one or two, but to start picking up the slack. She said she couldn't choose either. Her people were salaried and they didn't do overtime. I have to admit I was a bit taken aback. It was not a lot of time, for one thing, perhaps seven days at most. On other projects, I've seen schedules slip by weeks—many weeks. And another thing, I thought we had developed a good rapport and were able to work issues out with a little give and take. In this case, Mary was steadfastly opposed to telling her people to work overtime.

We argued about it for a while, and I decided to take it to a higher level, asking Eric Hoffman, who was the Chief Engineer at APL, to join us for a meeting of minds, and what I sincerely hoped would not turn into a very divisive discussion.

In the meeting, Mary pointed out something that was a no-brainer, really. It was so obvious that I was astonished and embarrassed that I hadn't realized it myself. Professionals don't have to be reminded that they have a job to do. All we had to do was put it out there for everyone to see that we were behind schedule, and they would rise to the challenge on their own. They would decide on their own to work the additional hours, and isn't that preferable to mandating that they do the work? Think about it from APL's standpoint, she said—if NASA told them to work harder than they already were, knowing full well that they weren't going to get paid for the extra hours, it would look a lot like NASA was trying to get something out of them for free.

I knew a number of people on the APL team because I'd worked with them before, and I recognized that what she was saying was true. These people would come in and work the extra hours; they would work Saturdays, Sundays, nighttime, whatever it took to do the job.

The only problem for me was that I had to go back and report to my management. I explained the situation to them: "This is the reason that we can't show it on the schedule . . . , but don't worry, they're going to do it on their own. They made me a promise." My management wasn't as confident as I was, but I was willing to use my reputation to persuade them to go along—and they did.

Ultimately they recovered all of the time. Whether or not Mary put it on the schedule, people were going to be there on the weekends getting the job done, and they were.

People who'd worked with me before at NASA were surprised that I had backed off the way I did. I didn't hide the truth. I said it was just basic psychology, and I gave Mary credit for teaching it to me. It's always better to let people come up with a good idea and implement it than for you to force it down their throat. When you deal with highly-skilled, highly-professional people, like the kind we worked with at APL, you treat them with the respect they deserve and you will get the kind of response out of them that you want without having to force it.

TWENTY-NINE

The 'Tried and True'

FRANK SNOW

GROUND SYSTEM AND FLIGHT OPERATIONS MANAGER

GODDARD SPACE FLIGHT CENTER

We were working on a simulation test, and one of the technicians was old school right down to the way he slicked back his hair and parted it on the side. Innovation, forget it. He would have none of that.

He called his methods "tried and true." It got to the point where Mr. Old School and another guy working the same simulation were ready to come to blows over his methods. I had step in to resolve that. I made it clear—while Mr. Old School's methods may be "tried and true," this particular simulation required a certain degree of open-mindedness.

I made the decision to let Mr. Old School go, and I called him into my office to let him know that he was going to be reassigned to another project. The only question I had for him was where he wanted to have lunch. "If it's all the same to you," he said, "there's no reason to break with tradition. The Chinese place would be fine."

Members of my team often went for lunch at a Chinese restaurant down the road from Goddard. The food wasn't great, but after you go to a place a few times, you've suddenly got a history there and the food doesn't matter so much. It was a good place to get away during the day when things weren't going well and folks needed to blow off steam. It was where we celebrated birthdays and project milestones, and it was also the place to go when we needed to let someone go on the project but wanted to soften any hard feelings.

I wouldn't want to give anyone the idea that project teams, even the successful ones, are "perfect families." For the good of the project and everyone involved, we occasionally had to get rid of people. I made it a policy that when someone was leaving the project because of a personality conflict, everyone on the team, or as many of us who were around that day, went out for lunch as a send off. End things on a pleasant note. In this case, sharing lunch together wasn't going to overcome the problems posed to the project by Mr. Old School, but if there was some bitterness—and sometimes there is—we were going to try to bury that and move on.

We started off with tea and egg rolls, and by the time the lo mein got to the table everyone was laughing and cracking jokes. Neither Mr. Old School nor the guy he nearly got into a fight with talked about their disagreement. The rest of us made sure to stay away from that subject.

Even though Mr. Old School and his counterpart couldn't agree on work, they had plenty to talk about. It turned out that they both had teenage daughters who were driving them crazy. In some ways, this is the kind of thing that can take the edge off of other differences. I could imagine them saying when they met each other again, in the cafeteria maybe, "Hey, did that little girl of yours get her driver's license?"

"Yeah, and she's still driving me crazy, but how about you?"

And this is the whole point of why we had our Chinese restaurant tradition. It rounded out the people on the project. The best way to smooth out differences between team members is to give them a glimpse of one another as people outside of their work. When someone has to leave the project, simple social occasions like doing lunch goes a long way toward healing hard feelings.

THIRTY

What Comes with the Territory

JOHN THURBER

OBSERVATORY MANAGER

GODDARD SPACE FLIGHT CENTER

One day I ran into Al Frandsen in the hall at Goddard, and I could tell he'd had a bad time of it in some meeting. It was obviously the wrong time to be asking him this question, but I didn't realize how wrong until it was too late. "Hey Al, when is Instrument X going to be delivered?" The instruments had a delivery schedule to go to the spacecraft developer (APL) and be physically integrated and checked out. One or two of the instruments were running late.

As the Observatory Manager for the Goddard project office, I was the primary interface between the instruments and the spacecraft. I was the one who had to lean on Al weekly—and, if necessary, daily—to know, "When are the instruments coming in?" As such, Al and I had something of an adversarial relationship early on in the project.

"Look, Thurber, what do you want, hardware or software? Because I can't give them both to you."

No doubt I should have said something friendlier to start with, but this was nonsense—hardware without software, software without hardware? "I think I need them both, Al," I said.

He was turning redder now. "Well, you tell me what you want me to do—because I can only deliver one to you now. Do you want the hardware or the software?"

I just stood there dumbfounded, my mouth hanging open. It was ridiculous. The conversation was going nowhere. All we were talking about here was his frustration. My finger was pressing his hot button and the sirens were ringing. He could either hit me or drop dead of a heart attack.

Fortunately, he saw there was no point in going any further with this, and he turned around and left. We let it go. The instrument got delivered, and it got integrated. It was certainly late, but when it came we had both the hardware and software.

Al and I continued to interact as we had before this incident, and we never had the same sort of heated exchange. When I was in California, he invited me and some others from Goddard out to his house for dinner. Nothing was ever said.

You deal with frustrations on a project every day. Project partners need to take care of each other. There are times when you need to push things, and there are times when you need to know to stop pushing.

THIRTY-ONE

Give it to Chuck

FRANK SNOW

GROUND SYSTEM AND FLIGHT OPERATIONS MANAGER

GODDARD SPACE FLIGHT CENTER

Officially, Chuck Athas was listed as my scheduler and planner. In the beginning of a project, we put together an extensive schedule. Maintaining the schedule, however, did not take up all of his time, and he was constantly looking for work.

Chuck would do anything I asked—and then some things I didn't dare to ask. All I had to do was put it out there that we had a problem. For example, when people weren't meeting a particular deadline, I could send out e-mails and phone messages, and they would conveniently not be around to respond. I could say to Chuck, "Go and find out what's happening," and he would be on it right away. If someone was slacking off or had issues they didn't want to fess up to, Chuck could turn things around just by virtue of his personality. I saw him work this way and it was magical. He never resorted to being confrontational, but boy could he lay a guilt trip on you: "You have to get it done. What do you mean? You're committed to this. The whole program is going to collapse."

It was impossible to argue with Chuck. He would say, "Let me help you. I'll do anything."

When someone would say, "I don't have the time," Chuck would come back with, "I'll do it, what do you need done?"

"Well, I have to get my daughter out of daycare."

Chuck's answer was, "I'll get your daughter out of daycare." Whatever needed to be done, he'd do it for you—anything.

I used Chuck to keep in contact with a guy named Chris, one of the engineers at the Johns Hopkins Applied Physics Laboratory (APL). Chris was very popular at Goddard. He was one-of-a-kind, an absolute genius, and usually spread out over 15 to 20 projects. If Chris couldn't solve a problem, then we were in trouble.

I would send Chris e-mails, leave him phone messages, and try contacting his supervisors—nothing. I can't say that he was definitely trying to avoid me, but he was probably trying to avoid me. But I also knew that if you could physically get hold of Chris, he would do your work. So it was Chuck's job to go over there, get hold of Chris and bring him back to me. I used to say to Chuck, "Find Chris because I absolutely need him," and Chuck would go to APL and literally sit outside of Chris's door until he showed up.

Chuck was also like the master sergeant in the army who has the inside knowledge of how to get supplies. Somehow things showed up and nobody understood how they appeared. They certainly weren't coming through procurement. He was trading, I suspect. I know that he used up a lot of the little things that we get for projects, like decals and posters. One time we needed six or seven headsets for communications on mission simulations. As the simulations approached, they still hadn't been delivered. I called Chuck and told him the problem, and he got it resolved. To tell you the truth, I don't know how he got them. And to be honest, I don't want to know.

Anything that needed to be done, and he didn't care what it was, he would attack with the same gusto and unflappable drive to succeed. Whatever it took to get the job done, Chuck would do.

Shaking It Up

APL was responsible for integration and testing (I&T) of the spacecraft and its instruments and providing the I&T ground support equipment, the chief component of which is the Integration and Test Operations Control Center (ITOCC). The Observatory was exposed to and tested for vibration, mass properties, acoustics, shock/separation/deployables, electro-magnetic compatibility, static magnetics, wet spin balance, dry spin balance, and thermal vacuum balance and performance.

The integration team used an innovative technique to run tests on multiple spacecraft systems simultaneously. This saved cost and schedule by shortening the time required to complete a full spacecraft test. . . . Two instruments were tested simultaneously by sending commands through separate command systems, but monitoring a single stream of spacecraft telemetry.

Source: National Aeronautics and Space Administration, *Advanced Composition Explorer (ACE): Lessons Learned and Final Report* (Greenbelt, MD: NASA Goddard Space Flight Center, July 1998), p. 104, p. 101–102.

Don't ask, don't tell. That was the best way I found to deal with Chuck. Was there anything he couldn't make happen? Probably something. But with Chuck on the team I felt like I could ask for Cleveland, and the next day he would show up with the deed.

THIRTY-TWO

Two Outs, Bottom of the Ninth

FRANK SNOW

GROUND SYSTEM AND FLIGHT OPERATIONS MANAGER

GODDARD SPACE FLIGHT CENTER

It was eight months before launch when my second Flight Operations team lead said he was leaving the project for another job, just six months after the departure of the original lead. I was stunned; I didn't expect to lose the second lead. After all, lightning's not supposed to strike twice in the same place. This time, with only eight months to launch, I was very concerned. No, "concerned" is too mild. Let's get it right—I was sweating bullets.

After launch, the Flight Ops team is the first line of defense when things go wrong. Sometimes the team has to make decisions in a matter of minutes, even seconds. They have to decide, "Do I need to do something quickly, or can I wait until I get some additional information and recommendations from the design engineers?" When the Flight Ops team needs to react quickly, they depend on their mission simulation training—but sometimes an anomaly occurs that can't be solved with the "canned" procedures. In situations like that, you need a Flight Ops team that can make decisions based upon a fundamental understanding of the spacecraft and its response to the ground testing.

We did several things on the ACE Mission that were new at the time for NASA. One was to bring the Flight Ops lead and a couple other members of the team on early. The first lead came to the project three and a half years before launch. That was unprecedented in all my years of experience as a Ground Systems Manager, but we wanted Flight Ops to participate in the definition, development, integration, and testing of the spacecraft, including the nine instruments, and then transfer this knowledge to the rest of the team.

With the loss of the second lead, and only eight months to prepare, I had a sinking feeling in my stomach. I was forced to rethink what qualifications I needed for the Flight Ops lead. No longer did extensive operational experience seem to be the one and only prerequisite. I needed someone who could turn eight people into a competent, cohesive, motivated team, and who could coordinate the activities of the Mission Operation team, a diverse group of scientists, engineers, and technicians. I needed a leader. Fortunately for ACE, we already had a member of the Flight Ops team who could do the job.

Jeff Volosin was good technically, but he was also respected by the other Flight Ops team members for his honesty, responsiveness, and dedication to the ACE mission. Jeff's leadership abilities became evident to everyone once he was appointed lead—he not only smoothed the frayed interfaces between the Flight Ops team and the other members of the Mission Operations team, but also found creative ways to train his team.

Members of the Flight Ops team performed software system testing for the Mission Operations Center, expanded their participation in the testing of the spacecraft, and supported the integration of the instrument test equipment into the Mission Operations Center. These activities provided the Flight Ops team with invaluable training, while developing excellent working relationships with the various operation support teams. To meet these additional responsibilities, especially the last two months before launch, the Flight Ops personnel worked 10–12 hour days, as well as weekends. I never heard any serious complaints; the Flight Ops team saw this difficult task as a unique opportunity.

The greatest reflection of Jeff's character was that he did all of this and was never in fact the official Flight Ops team lead. His management told me that Jeff didn't have the requisite experience to be a lead. Instead, they had someone else they wanted. Okay, I said, the last thing I needed was a fight, but I pushed to have Jeff made the deputy lead. The official lead handled the programmatic aspects, meaning the paperwork and other administrative tasks, while Jeff was the Chief Operating Officer who handled the personnel.

Jeff enjoyed his work and strove for excellence in every assignment that I gave him. His enthusiasm and dedication were contagious, affecting both the Flight Ops team and the other groups that worked with him. Recognizing Jeff's leadership qualities and assigning him the Flight Ops team lead, albeit unofficially, was one of the best decisions I made during the whole project. He validated my belief that when you have only one out left, you want a leader at the plate.

THIRTY-THREE

Customer Responsiveness

MARY CHIU

PROGRAM MANAGER FOR SPACECRAFT DEVELOPMENT

JOHNS HOPKINS APPLIED PHYSICS LABORATORY

If you know anyone who's been involved in building a spacecraft, I'm sure you've heard the mantra, "Test what you fly, and fly what you test." Listen to a project manager from APL talking in his or her sleep, and this is what you're likely to hear.

At APL, we do a lot of testing. We probably do more testing in the initial stages of a project than we could explain to review boards. Perhaps we are conservative in this respect, but our project managers and engineers believe in getting a good night's sleep before a launch, and testing is a good way of ensuring that.

So you can imagine my dismay when Don Margolies suggested that we pull all of the instruments off the spacecraft after we had just completed the full range of environmental testing. This was to allow the scientists to do a better job of calibrating their instruments. After I picked myself up off the floor, I began to think about that other mantra we hear quite a bit in this industry: “The customer is always right.” Maybe in theory.

One thing I learned on ACE is that you have to decide when something is worth putting your relationship with the customer in jeopardy. There were times when I didn’t agree with what Don Margolies wanted, but I was still going to do whatever I could to accommodate the request. The customer is always right—again, in theory—but nothing in a space flight program is a simple change, and there may well be ramifications that you don’t realize until later.

To his credit, Don consulted with me over the decision to pull the instruments; he listened to my concerns, worked around my objections, and, in the end, treated me as a partner. Now contrast this with what occurred earlier in the project. It was a different experience than we’d had with the data handling system, and it illustrates the importance of what people can accomplish in a spirit of cooperation.

In the case of reintegrating the instruments, I was able to work with the customer despite disagreeing about what they were asking us to do because we kept in mind that we both were aiming for the same goal: a successful mission. Still, I remember how sickened I felt when we had just come out of the last thermal vac test at Goddard and, one by one, the instruments, nine in all, were pulled off and returned to their developers for calibration testing.

It isn’t something I would want to do again. I would do it, however, if I found myself in the same situation—if I was working once again with a reasonable customer who understood that it wasn’t just something he wanted, but something we were going to have to work through together.

A Ground Breaking System

ACE was the first major NASA mission to adopt a common ground system (i.e., the same core hardware and software) for the I&T (integration and testing) ground system, the mission operations ground system and the science data center ground system. This achieved significant savings.

Source: National Aeronautics and Space Administration, *Advanced Composition Explorer (ACE): Lessons Learned and Final Report* (Greenbelt, MD: NASA Goddard Space Flight Center, July 1998), p. 2.

THIRTY-FOUR

The Broad View

DR. EDWARD STONE

PRINCIPAL INVESTIGATOR

CALIFORNIA INSTITUTE OF TECHNOLOGY

After testing was completed, the scientists wanted the instruments to come off for recalibration. APL wanted them to stay on the spacecraft. The question was “How much does taking off the instruments increase risk?” In my view, not calibrating them properly increases risk as well—the risk of not getting good science.

It comes back to “What’s good enough?” Ideally, we wouldn’t have taken the instruments off. At the same time, this was not the first time such a procedure had been followed. I had personal experience with this. On the Voyager mission, where I was Project Scientist, some of the instruments were taken off and recalibrated when the spacecraft was shipped to Florida for launch. On ACE, we wanted to take off all the instruments, but because of the way the instruments were mounted on the ACE spacecraft, they should have been relatively easy to remove and reinstall.

As the project manager, Don had the ultimate responsibility to decide what to do, but I wanted him to understand the importance of recalibration for the scientists, and this came down to explaining what I considered to be the broad view of the issue.

Engineers who design a spacecraft have learned something before it launches, and they can take their knowledge with them onto other projects. But scientists haven’t actually learned anything until the spacecraft is in orbit and they can try their instruments. Reintegration, while it was certainly a doable task, would be no small matter for Mary Chiu and APL. There were real engineering issues. The job of the project manager was to balance the interests of the engineers and the scientists so that we ended up with an optimal system. I was going to stick my neck out and guarantee Don that the instruments would be back on time for reintegration, but I recognized it was still his decision to make.

THIRTY-FIVE

Test What You Fly?

DON MARGOLIES

PROJECT MANAGER

GODDARD SPACE FLIGHT CENTER

You’ve heard the expression, “Test what you fly, fly what you test.” It’s hard to argue with that in theory. In this case, it was a risk I was willing to take.

The ACE observatory had a suite of nine instruments and an electronics box that interfaced with a number of the instruments. We planned from the outset of the project to remove three of the instruments for recalibration and to have

microchannel plates replaced. Our implementation plans took this into account, and we developed retest programs for the individual instruments. Subsequent developments changed this plan significantly when I authorized the removal of all instruments and the electronics interface box.

As the project manager, I ultimately made decisions about what risks to take, just as it was my responsibility to get buy-in from the stakeholders. It was the first time on any NASA project that I know of when all the instruments on an observatory came off for rework or calibration after the full range of environmental tests and then were reintegrated at the launch center without the benefit of an observatory environmental retest.

Several people on the project thought I was crazy. Why do it? We had gone through our environmental test programs successfully and everything seemed to be operational. If it's not broken, don't fix it, right? Normally, I would take the pragmatic approach: "Your instruments are working, and good enough is good enough." On the other hand, we had more than adequate slack in the schedule, and we were coming in \$30 million under budget—amazing, I know. We were in a position to ask, "What can we do to make the science better?"

Given that we had the schedule, given that we had the money, one answer to the question was better calibration. For those who had only completed marginal calibration prior to testing, the alternative was to calibrate again in orbit. Calibration in orbit takes time, and it's not as precise as on the ground. So there really was a net benefit to the science by doing this. If the scientists had the opportunity to tweak and calibrate their instruments on the ground, they would most likely get better science in space. In order to provide a proper return on the \$100 million NASA investment, ACE, an Office of Space Science mission, had to perform on all cylinders, so to speak.

But how do you know the risk is low enough to put an instrument back on without retesting it under vibration? That was the question my management put to me. When I approached them about this, they didn't mince words. "Don, you are crazy," they told me." But I knew I was going to hear this, and I was prepared to explain.

The way that the spacecraft was designed made the job of removing the instruments and reintegrating them very simple. The instruments were mounted on the outside of the spacecraft and were easily accessible. To remove them, you disconnected the connectors, and there weren't that many, removed the mounting bolts, and lifted off the boxes. When you re-bolted them down, you made sure of their mechanical integrity, and you did functional tests on each of the instruments to verify that they were working. The solar panels were off at this point, so even if we had to get into the guts of the spacecraft that wouldn't have posed a problem.

That all may sound well and good on paper, but you don't persuade your management to do something it doesn't want to do just by sounding logical. When you want to do something this different, you have to be cool and clear in how you present the issue. The last thing you want to appear is impulsive. Upper management sleeps better when they know that protocol has been followed, and

consequently, a project manager sleeps better when he knows that his management isn't tossing and turning about a decision he's made.

"Yes," I admitted, "when we reintegrate everything we will not have the same degree of certainty as we did before the testing. Without another vibration test, no one would ever be able to say categorically that these instruments will hold up under the stress of the launch."

Ultimately, I was able to get management to buy off on the decision, but not without first undergoing an independent review of our plans. The review board agreed with me that, based on the design of the spacecraft, reintegration would be "less complex" than it could have been. The fact that all instruments would be environmentally tested before they were returned to the spacecraft also helped.

There were other stakeholders, including those at Headquarters, whom I had to convince. The one I was most concerned about was Mary Chiu. It was APL's responsibility to reintegrate the instruments, and I knew that. Mary wasn't pleased when I told her what I wanted to do. In fact, it was she who reminded me before anybody else, "Test what you fly, fly what you test." Mary never yelled or screamed or jumped up and down and said "No, we can't do this." Nor do I remember her joining the chorus in saying, "Don, you're crazy." But she did voice her displeasure in writing, and it was not something I took lightly.

We talked about it exhaustively, especially in terms of what the impact would be on her team. Mary was a key part of the planning process because it was going to be up to her people to reintegrate the instruments, as well as all the other things we needed to do as the launch date approached. Clearly, I wouldn't have agreed to this had the APL team said it was an impossible risk. Getting Mary's buy-in, albeit a reluctant buy-in, was a major precondition for going through with it.

I left it up to Mary to decide when she needed all the instruments back. If all the instruments showed up on the door the same day, Mary's team would have to hustle, and I didn't want that. The APL team was working very hard as it was, and I had to make sure they were taken care of; so Mary's schedule dates were the dates that the scientists committed to.

In order to consider taking on this risk, I also had to have complete faith in the scientists. How did I guarantee their full cooperation? The scientists were told that if they did not get their instruments back in time they might not fly. They understood this, and more importantly, believed it. I know they did because Dr. Stone stood behind me on this.

I insisted that each of the Co-Investigators write a letter to him promising that they would return their instrument no later than the date given them. I don't know whether they would have written such a letter to me, but based on what I had seen so far, I knew that once they promised Dr. Stone, no matter what condition the instrument was in, whether it was fully calibrated or not, it would arrive by the day they had promised.

Our Science Team knew that our primary objective was to launch on schedule. They also knew that because of some science overlap in the instruments, we

would be willing to leave an instrument on the ground if we had to. The truth of the matter was that despite what we had said outwardly, our goal was always to fly a complete science suite, with all instruments functioning as well as they could, and with all the appropriate calibrations.

And so it all worked out in the end. The orderly return of the instruments didn't happen exactly as we had planned, but due to the skill and dedication of the APL team, we reintegrated the instruments at the launch site. This happened because people were willing to work with one another to make it happen.

ACE Viewing Set for 12 August 1997

NASA's Advanced Composition Explorer (ACE), to be launched aboard a Delta rocket from Cape Canaveral later this month, is the subject of a news media opportunity on Tuesday, 12 August at 12:30 p.m.

Media representatives will be taken inside the clean room at the SAEF-2 spacecraft checkout facility located in the KSC Industrial Area. Those planning to attend are requested to wear long pants and closed-toe shoes. Clean room attire will be provided. Quality control personnel will request cleaning of photographic equipment with alcohol wipes, which also will be provided. No suede, leather, or vinyl attire or accessories will be permitted in the clean room, and ladies are asked not to wear makeup. Special plastic bags will be provided for photographic accessories.

Source: Press release, National Aeronautics and Space Administration, Kennedy Space Center, "ACE Spacecraft Media Opportunity Scheduled at KSC August 12." Accessed 1 November 2004 at <http://www.pao.ksc.nasa.gov/kscpao/release/1997/139-97.htm>.

THIRTY-SIX

Turf Battles

JOHN THURBER

OBSERVATORY MANAGER

GODDARD SPACE FLIGHT CENTER

One thing you don't want to do is offend the safety team at Cape Canaveral days before you're scheduled to launch. It may be your launch, but this is their turf. That's why I went into a panic when APL's Integration and Test (I&T) manager said, "We're going to get this thing launched and we're going to do it on time. I don't care what Safety has to say about it." This was at a meeting in front of 20 or 30 people, including the head of Safety, who was seated next to me.

I knew I was going to have to start groveling right away. “He didn’t really mean that,” I said, following the Safety manager out the door. Maybe he was just clearing his throat, but to me it sounded like a growl.

At the Cape you are at the mercy of the Safety group. In some ways, you can’t move without their approval. If you have to move a rack from one place to the other, and have to pick it up and set it down with some cables, the crane operator won’t operate the crane without a Safety person on site. Suddenly, Safety wanted to review all of our documentation.

It was an awkward situation. APL had to back off. They were a NASA contractor, so it was up to us to do whatever was necessary to make friends with Safety. I did what I could to make them feel important again. I understood their point of view. This was their job, and they weren’t about to defer responsibility because someone said they could go home. They don’t want to hear that their team is anything less than integral to the project. At the same time, I could also understand the INT Manager from APL. He believed that he had done everything safely and didn’t need anybody to be second guessing him.

In the end, this didn’t hold up the launch, but it was a challenge to try and reschedule people to do things after Safety took three days to review our documentation, making sure every “i” was dotted and every “t” crossed.

The lesson here is pretty clear: Everybody has a piece of turf, and you’d best respect that. You never know how much your lack of respect may cost you.

THIRTY-SEVEN

Happy Birthday

DON MARGOLIES

PROJECT MANAGER

GODDARD SPACE FLIGHT CENTER

On the Pad

ACE, aboard a Boeing Delta II rocket, is currently scheduled for launch on 25 August at the opening of a launch window which extends from 10:39–11:05 a.m. Liftoff will occur from Pad A at Launch Complex 17 on the Cape Canaveral Air Station.

Source: Press release, National Aeronautics and Space Administration, Kennedy Space Center, “ACE Spacecraft Media Opportunity Scheduled at KSC August 12.” Accessed 1 November 2004 at <http://www.pao.ksc.nasa.gov/kscpao/release/1997/139-97.htm>.

Three and a half years prior to our launch, we had to establish a launch date. I wanted the date to be 30 August, because that’s my birthday. It turned out that the moon was in the way, and in order to launch on 30 August we would have

to do phasing loops and stuff, and that's crazy. So we backed off a week or so, and set the date for 21 August 1997.

Just a few weeks before the big day, McDonald Douglas, our launch vehicle contractor, came to us and said, "We have a launch on the West Coast a week before yours, and we don't like to do a launch on the West Coast and then one on the East Coast in less than a two-week interval."

I said, "That's too bad. We want to launch on this date; you find a way to make it happen." Sure enough they found a way to circulate their troops from the west coast to the east coast to support the launch. Everything appeared set, we were marching towards our launch date of 21 August, and then another wrinkle appeared in the fabric. The mission scheduled to launch before ours, for whatever reason, got pushed back, and was going to delay our launch by three days.

The launch ahead of ours was a Lockheed mission, nothing to do with NASA, so it seemed like there was little influence I could have on the matter—but I decided to try anyway. I called the Lockheed vice president responsible for the division that had this satellite, and was able to get his mission to stand down so that we could launch on the 21st. The sun was out again, the stars were shining, and everything was right with the world—until I got a phone call a couple of days later. Corporate overruled the vice president, and Lockheed was going to launch ahead of us come hell or high water.

I took this call while I was at Kennedy Space Center. It was the end of the day, and I was so upset that when I left to drive to my hotel I never slowed down as I approached the gate. The guard flagged me, and I got a ticket.

Some project managers are like a bull in a china shop. Sometimes that may get you what you want. My approach has always been to try to be a little more diplomatic, so let me just explain why I let myself become a bull in a china shop over this.

We had put a launch date down three years earlier, and we had a chance to nail it right on the head. At that time in NASA, this was unheard of. Normally, missions missed their launch date by 3–6 months, and I knew some that had missed by 12–24 months. In that three years since we had established our launch date, people had kept their nose to the grindstone to make that date, and I was extremely proud of that. Something else I'm proud of: the final project cost was \$106.8 million, a \$34.3 million underrun for a 24 percent savings. We were able to do that because we were fully funded through the end of 1997. We had made a commitment to NASA Headquarters to launch no later than the end of '97, but August was always our target launch date. We had a target launch date and a no-later-than launch date. That \$34 million was four months of schedule reserve, plus some contingency dollars we never needed to use.

As it turned out, we launched on 25 August, and it was a beautiful launch. The rocket leapt off the pad and sailed out of site, and five days later I had a wonderful birthday.

On 25 August 1997, ACE was successfully launched from Cape Canaveral Air Force Station on a Delta-11 7920 expendable launch vehicle. Then four months of orbit maneuvers took ACE to its mission halo orbit around the L1 libration point in the latter part of December 1997. During this period all instruments were outgassed and then turned on for checkout and calibration during the cruise to L1. It was during this period, on November 4 and 6, 1997, that two large energetic solar particle events occurred. Most of the ACE instruments were able to obtain data from these events and produce outstanding scientific results.

Source: National Aeronautics and Space Administration, *Advanced Composition Explorer (ACE): Lessons Learned and Final Report* (Greenbelt, MD: NASA Goddard Space Flight Center, July 1998), p. 4.

THIRTY-EIGHT

Passion and Play

FRANK SNOW

GROUND SYSTEM AND FLIGHT OPERATIONS MANAGER

GODDARD SPACE FLIGHT CENTER

Though I've long since moved on to other projects, I still get reports probably on a monthly basis from both the ground system team and the scientists. I read them because I'm still curious about how the mission is going. I'm happy that the ground system is working so well and the scientists are getting lots of good data.

But when I think back on ACE, my memories aren't of the technical sort. They're of the fun I had working with such excellent people, people who had a passion for their jobs. And that is the word I like to use. They all displayed "passion," no matter what the job. It's always fun working with people like that, and I enjoyed it very much.

Bottom Line Results

Below is a cost breakdown for the starting baseline Program Operation Plan (POP 93-1) and the final (POP 98-1).

ACE Planned and Actual Cost in Real Year Millions

	Planned POP 93-1 (M\$)	Actual POP 98-1 (M\$)
Project Management	6.8	5.1
Spacecraft	52.1	47.0
Science Payload	53.4	50.2
Ground Systems	2.6	1.5
Performance Assurance	2.2	1.2
Flight Operations	2.2	1.8
Subtotal	119.3	106.8
Contingency	21.8	0
Total	141.1	106.8

The primary conclusion is that the ACE project performed significantly better than historical expectations The management took the fixed price mandate very seriously. First, the contingency and schedule reserve were “banked” early in the project with the desire to manage without them. Second, the fixed price concept was used throughout all elements of the project. Third, schedule was maintained tightly, which provided a control of cost It appears the [Goddard] Explorers Project Office, in conjunction with Headquarters [Office of Space Sciences], have constructed a more efficient mode of project management. One that fits well with the NASA concept of faster, better, cheaper.

Source: National Aeronautics and Space Administration, *Advanced Composition Explorer (ACE): Lessons Learned and Final Report* (Greenbelt, MD: NASA Goddard Space Flight Center, July 1998), p. 30. Also available at http://www.srl.caltech.edu/ACE/ASC/DATA/pdf_docs/LessonsLearned.pdf.

Chapter 3

FAST LEARNING, FASTER UNLEARNING: JASSM



JOINT AIR-TO-SURFACE STANDOFF MISSILE

In December 1995, Air Force Program Director Terry Little was asked to rescue the floundering Joint Air-to-Surface Standoff Missile (JASSM) program. JASSM, a joint effort between the Air Force and the Navy (with the Air Force as the lead service), was established in the fiscal year 1996 budget to replace the cancelled Tri-Service Standoff Attack Missile (TSSAM) program, which had exceeded its budget estimates by record levels.

Prior to Little's arrival, JASSM appeared on its way to swift cancellation, and that was the point of bringing on Little, whose reputation as a successful Air Force program director was widely recognized. But JASSM would prove to be one of his most challenging assignments. The overriding focus with JASSM was affordability. Skittish over the failure of TSSAM, the Office of the Secretary of Defense would have no patience to continue the program if Little did not demonstrate that he could bring it under control quickly.

The build-up to the government's Request for Proposal was a period of intense interaction between the government team and the five companies competing for the contract. A 24-month program definition and risk reduction contract would be awarded to just two of the companies, who would then compete for the down-select award to continue through full-scale engineering and production. To produce an affordable missile, Little adopted a strategy that was as bold as it was new, and in the process challenged his government team and industry partners to completely rethink existing paradigms of acquisition reform.

SOURCES:

Terry Little, Project Director, U.S. Air Force
Larry Lawson, Vice President, Lockheed Martin
Brian Rutledge, Financial Manager/Program Manager, U.S. Air Force
Lynda Rutledge, Systems Engineer, U.S. Air Force
Jackie Leitzel, Contracting Officer, U.S. Air Force

ONE

Happy New Year, 1996

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

In late December 1995, I got a call to come in and talk to one of my bosses at the Eglin Air Force Base. At the time, I was program director for the Joint Direct Attack Munition (JDAM) missile. Our program was going well, so I wasn't worried about the meeting.

As soon as I got there, I was told that I was being switched off JDAM to run the Joint Air-to-Surface Standoff Missile (JASSM) program, and I wasn't happy about that. I had started the JDAM program, and I was quite content there. In fact, I intended to finish out my career in the Air Force on that program. I asked about the person I was replacing, and the answer I was given was terse, "He wasn't up to the task."

The original program director on JASSM was put in place at the start and given two major mandates. First, do not repeat any of the mistakes of the past. This was a reference to another program, the Tri-Service Standoff Attack Missile (TSSAM), which was cancelled after six years and several billion dollars in cost overruns. It was considered an unmitigated disaster, and all subsequent missile programs had to establish early on that they were not going to repeat the mistakes made by TSSAM.

The TSSAM Debacle

In 1986, the Air Force began developing TSSAM to provide a low-observable conventional cruise missile. Key characteristics included long range, autonomous guidance, automatic target recognition, and precision accuracy with a warhead able to destroy a well-protected structure. After the TSSAM procurement unit cost increased from an estimated \$728,000 in 1986 to \$2,062,000 in 1994 (in dollar values for those years), the Department of Defense (DOD) terminated the program.

Following a comprehensive reassessment of force requirements, the Air Force and Navy agreed they urgently needed an affordable missile with most of TSSAM's characteristics. They proposed a joint program that would build upon the lessons learned from TSSAM and more recent programs that use new acquisition approaches.

Source: General Accounting Office, *Precision-Guided Munitions: Acquisition Plans for the Joint Air-to-Surface Standoff Missile* (Washington, DC: GPO, GAO/NSIAD-96-144, 28 June 1996), p. 3.

The second mandate was to get started quickly. JASSM began officially in April 1995 with about \$4 million. Unless the program established quickly that it was serious about getting on contract, it was unlikely that money would be made available through the next fiscal year. The TSSAM debacle made it difficult for all subsequent programs. The attitude down at the Office of the Secretary of Defense (OSD) was: Show that your program is serious, and show it fast—or don't expect to be around long.

The immediate objective was to award contracts to two competitors who would spend the next two years designing a system that would be continuously evaluated. At the end of the two years, the government would award production of the missile to one contractor. My predecessor and his team had worked on the contract since April, but they couldn't find a way to make the source selection quickly. Too many things still needed to be done; it looked as though it was going to take the government team another year, and that was unacceptable to senior management, especially at OSD.

When I was brought on, we still needed to get the formal requirements approved by OSD, get the contractors focused on making a serious proposal, field their proposals, and do the evaluation. Five companies were interested in competing for the two contracts: Hughes, Texas Instruments, Raytheon, Lockheed Martin and McDonnell Douglas.

"You just go down there and do your thing," I was told as I left my boss's office. Nothing more than that in the way of concrete detail. The rest was up to me, I guess.

I called a meeting the first day back after New Year's, January 3, with the 20 people who were working on JASSM. They were in a state of disbelief after learning that their boss had been fired over the Christmas holidays. He had worked with them on this program from the beginning and was well liked. Out of the blue, I showed up and told them, "We are going to get this program on contract within six months."

Somebody raised his hand and said, "You're new and you don't understand. We've been working on this nine months, and there's no way we can get on contract in just six more months. There are too many things that have to be done. We've tried to make it go faster, but we just can't do it. You need to understand a little bit more before you decide something like this."

I stopped him mid-sentence, "No, you need to understand something—if we don't do it in six months there is no program. We're going to have to figure out how to work together to make this happen. You tell me what kinds of things that I have to do and I'll do them, but first you need to put aside all of your paradigms and all of your ideas about how exactly we are going to do this and start with one basic assumption: that it's going to be done in six months."

I told them that we would meet again in three days, and I expected to hear everyone's ideas for how we were going to meet the challenge.

The next day, three people from the group came to my office. These were the spokesmen for the whole group. They told me that I needed to reconsider—I was being unreasonable and I really didn't get it. They told me that I had agitated everyone because I was asking them to do the impossible.

It's funny because, thinking back on it now, I realized that I had never tried an approach like this before. I had no idea why I thought it could work, but tears welled up in my eyes, and my voice broke as I said, "God damn it, you are going to make me do this myself, aren't you?"

They looked at one another, confused, and one of them finally said, "What do you mean?"

"I am counting on you," I said. "I am empowering you, as a group, to go figure out how to do this. My job, as the leader here, is to facilitate things, to do whatever's necessary to make the bureaucracy move out of our way, so that it parts like the Red Sea parted for Moses—that's my job. But here you are giving up, and you haven't even started."

That silenced them, literally stopped them in their tracks. The meeting ended that quickly. I didn't know what would happen when I saw them or the others on the team next. Before they left my office, they said we should talk more about this with everyone on the team at our next meeting. I had a lot riding on that meeting.

TWO

Parallel Tracks

LARRY LAWSON

VICE PRESIDENT

LOCKHEED MARTIN CORPORATION

I joined the JASSM program at the end of 1995, a couple of months before Terry. Initially, I was not excited about the assignment. I had a great job, and I was very close to my customers. Like Terry, I was brought on board to replace the person who started on the program, and I was expected to turn this activity around. Within the company, the perception was that we were in sixth place in a field of five competitors.

I told my boss that I really didn't want to take on the JASSM program this late in the first round of competition, but he was convinced that I was the right match. Over the course of my career, I had worked in aircraft, electronics, sensors, and, to some extent, missiles. I had led a number of large competitions and really enjoyed working with customers. The meeting ended with, "We believe this is the right thing to do, and you start tomorrow."

Earlier in the year, Lockheed and Martin-Marietta had merged; we were experiencing what I would call "merger indigestion." I didn't know if I could pull the Lockheed Martin team together in time to win this first phase of the program, and then perform to win the final phase. Given the time constraints, I didn't have

an opportunity to build a new team. When I met with the team, their overwhelming welcome and the team's desire to get to business was very encouraging. I decided to start by understanding the customer's vision. We would soon establish ours.

THREE

Shock Therapy

BRIAN RUTLEDGE

FINANCIAL MANAGER

U.S. AIR FORCE

JASSM was not the first program I had worked on with Terry Little, so I had already undergone some of his shock techniques. The first time I worked for him, I had been told in advance, "You're going to work for Terry Little down in the Black World (classified programs). He just fired the major you're replacing. Show up there tomorrow morning. Good luck."

My job was to prepare estimates for two of his programs. Terry didn't think there was a need for a large staff, and first among those he viewed as extraneous were the financial management people. I worked there for three months, and he wouldn't even say hello to me when he walked past my desk in the morning. When I finally approached him to talk, his response was "Good morning—now get out of my way."

The reason the finance manager before me got fired was because he couldn't figure out Terry's personality. Terry had challenged him on his cost estimate—Why did you do this? Why did you do that? After several rounds of this, my predecessor finally said, "I give up, what number do you want?" But that's not what Terry wanted to hear. You don't ever say to Terry, "What do you want?"

Terry expects you to defend your position. If you can't defend it, he'll tear you apart. So after three months, I had to go in and defend my estimates to him. We went head to head and he challenged me on every little thing, but I stood my ground. About a week later, he came up and sat down at my desk and started a conversation with me for the first time.

To my surprise what he told me was that I needed to get out of financial management and become a program manager. As I soon learned, that's Terry's way of telling you that you've done well. If he takes a shine to you, he suggests you'd make a good program manager. From then on, when I brought something to him, he trusted me, and that trust grew. About a year later, I got promoted and left Terry and that program behind.

When Terry was selected to take over JASSM, I was already working on the program. I knew some of his antics, so I was half expecting something dramatic on his first day. He didn't let me down.

What's a JASSM?

JASSM is a low-observable, highly survivable, subsonic cruise missile designed to penetrate next generation air defense systems encountered en route to its assigned target. The missile enables the delivery platform to standoff outside enemy area defenses. The weapon's precise attack capabilities enable JASSM to place high-value, fixed, relocateable point targets at risk while minimizing aircrew and launch platform exposure to enemy air defense systems.

The missile weighs a maximum of 2250 pounds, is 168 inches long and approximately 18 inches in diameter, and carries a 2000-pound class, hardened, penetrating warhead.

Source: U.S. Air Force, "JASSM Launch and Leave Subsonic Cruise Missile Design," Air Force Armament Team News Connection (Eglin AFB), 1999.

It was January 3, and a lot of people were still on Christmas and New Year's leave, but Terry scheduled a mandatory meeting and required that everyone show up. He came into the room where we had assembled and, before even introducing himself, said, "We're going to be on contract by July, and anybody who's not on board with that might as well look for another job."

He scared a lot of people. Some people weren't sure they would still be in the JASSM program office by the end of the month. He had a reputation, perhaps unfairly, of not hesitating to fire people when he thought it necessary.

FOUR

Taking Aim

JACKIE LEITZEL

CONTRACTING OFFICER

U.S. AIR FORCE

At one of the first meetings after Terry came on board, he showed us several charts about teaming and shared goals and other things like that. We were a small team at that point, there were 25 of us altogether. He wanted everyone to commit to a common goal, which was to be on contract by July.

Before Terry arrived, we were just spinning our wheels, so I understood what he was saying about the problem of people having different goals. Before he came, Logistics might be saying one thing while Testing was saying another, and I would have to go to the program director to ask which version we were going with—and even then I still didn't get a clear-cut answer. Terry got us focused fast. We had the same goal: six months to get on contract. Suddenly we knew what we were aiming for.

FIVE

Epiphany on the Side of the Road

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

Earlier in my career, I had a conversation with someone who was working for me on a program. This had a tremendous impact on how I manage and why I place so much importance on establishing goals for the project and seeing that the team embraces them.

Late one night, this colleague and I were driving together and got involved in a car accident. Neither of us was hurt, but the car was wrecked and we had to call for help. As we were waiting on the side of the road for the police to come, I was joking with him about all the things that he was insisting I do in his area. This person was in charge of security on the program, but he could have been any functional type person. “You are going to bankrupt the program,” I said. “We are going to have all the security we could possibly need, but there won’t be a program anymore.”

“That would suit me fine,” he told me, and he was serious. “The rest of the program is not my job; it’s not what I get measured against. Security is my job.”

Looking back on this, I remember it being such a shock to me that he would say, in effect, “I really don’t care about the program. That’s your job. I only care about my own sandbox.”

His comment led me to start questioning some of the people I worked with. I had assumed that everyone I was working with looked at things from the perspective of what was good for the program as a whole, that they wanted the whole program to be successful, and that their own special area was secondary.

What I found out was that he was not unique—virtually none of the people who worked with me had the same goal that I did. Their expectation was that I, as the project leader, would integrate all of these different narrow vertical goals. It was my job alone to care about what was good for the program as a whole.

That was an enlightening experience for me, and it’s why I believe that making absolutely sure that everyone has a clear understanding of what we are trying to do is critical—and I expect clear buy-in on that.

The Program Manager in Defense Acquisition

Program management provides for a single point of contact, the program manager, who is the major force for directing the system through its evolution, including design, development, production, deployment, operations and support, and disposal. The program manager, while perhaps being unable to control the external environment, has management authority over business and technical aspects of a specific program. The program manager has only one responsibility: managing the program, and accountability is clear. The Defense industry typically follows a management process similar to that used by DOD. Often contractors will staff and operate their program office to parallel that of the government program they support.

Source: Department of Defense, Defense Acquisition University, *Introduction to Defense Acquisition Management*, Fifth Edition, (Fort Belvoir, VA: Defense Acquisition University Press, 2001), p. 13.

SIX

Like A Hurricane

LYNDA RUTLEDGE

SYSTEMS ENGINEER

U.S. AIR FORCE

I joined the JASSM program in the fall of 1995, a few months before Terry Little. During my first week on the job, I was told to conduct a working group meeting with all the contractors. The person who had been running these meetings turned them over to me.

The program had formed working groups for each critical program area with the five companies that were competing for the contract award. The purpose of this was to ensure that each of them heard the same information. My job was to decide which mathematical models would be used, to make sure everybody understood them, and to arrive at some consensus among the five companies. These were models measuring weapon effectiveness, the probability that the missile would come off the airplane, the probability that it could fly to the target and survive without getting shot down by some sort of surface-to-air missile, and the probability that it could kill the target—that sort of thing.

A few days before my first meeting, one of the worst hurricanes ever to hit Florida blew through Eglin Air Force Base, where the program normally held its working group meetings. The meeting was rescheduled at Wright Patterson Air Force Base in Ohio. I remember the meeting well, because it felt as though I had left one hurricane and stepped into another.

Foundations of Acquisition Reform

There have been many attempts to reform the federal government procurement process over time. However, in the early 1990s, it became clear that the rapidly changing threat environment, reduced resources, and changes in technology development required permanent changes in the way DOD acquired defense systems Given the changes in the threat and downward pressure on the budget, DOD could not continue to conduct business as usual. Further, the fast pace of technological advances in the commercial market created a real need for access to this technology before potential adversaries could buy it. Therefore, the Department fundamentally changed the way it acquired systems—that is, more efficient and effective ways to acquire goods and services faster, better, and cheaper.

Source: Department of Defense, Defense Acquisition University, *Introduction to Defense Acquisition Management*, Fifth Edition, (Fort Belvoir, VA: Defense Acquisition University Press, 2001), p. 15–16.

Working groups are supposed to be small. All the ones I'd been part of before included just a handful of government and industry representatives. When I opened the door, I found close to a hundred people in the room. Most of them were much older than I was. I'm sure that when I walked through the door they were thinking, Here's this young and inexperienced person, this woman. She doesn't know what she's doing, and we're going to walk all over her. Instead, they learned quickly that, number one, you don't walk all over me, and, number two, I am decisive.

"From now on, I intend to limit the number of people who can attend these meetings," I said. I was blunt with them, "You can't conduct a working group meeting with this many people."

The companies had learned that the best way to get what they wanted from the original program director was by whining. Every time they complained, he tried to appease them. They went back to the program director and complained about me. He said that he was shocked—that's not the way he intended for me to behave.

When Terry came on, the best thing that he did after setting our July contract goal was to say, "I'm going to trust you guys to do the right thing to meet our goal, and I'll back up whatever you decide to do."

I said, "Good—now I can execute what I think needs to be done." I wouldn't have to worry anymore that the program director would overrule me every time one of the companies complained.

SEVEN

Scheduling the Donuts

BRIAN RUTLEDGE

FINANCIAL MANAGER/PROGRAM MANAGER

U.S. AIR FORCE

Terry's predecessor demanded that we keep meticulous schedules of our daily activities. He wanted to know what I was doing every day down to the smallest detail. This applied to all of the leads on the program.

I was responsible for putting together the affordability portion of the Request for Proposal, and it was just me and one other person working with five companies. To prepare a schedule as it pertained to five companies on a daily basis was a terrible burden. I felt as though I was spending more time documenting my activities than doing our actual work.

This came to a head one Friday at a 6 P.M. meeting. Someone put up his schedule on the overhead. The next week we were going to have an Industry Day, where the companies would all send representatives to Eglin Air Force Base. The schedule on the overhead included a line that said, "Drive to the bakery, pick up donuts." The deputy program director commented that this was exactly what he wanted to see in our schedules.

It may have been because it was a Friday night—the end of a long week—and I was beat; but when I heard him say this I stood up and declared that it was the most ridiculous thing I had ever heard. "If you want me to write down when I go to get donuts," I said, "I'll never get to the finish line."

Yes, you need schedule, but you also need to be reasonable.

EIGHT

McNamara, I Am Not

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

People who want to work for me are the kind of people who are not afraid to be accountable for results. When it comes to making decisions on technical aspects of a program, I am quite content to let the people who work for me do that. Seldom do I intervene or get involved in the details.

Sometimes people let me know what was decided, and other times they don't. There are program decisions, multiple decisions, being made every day without my prior approval. When someone is new and I haven't taken the full measure of them yet, I will ask him or her to let me know what's going on, what they've decided—but after I am comfortable with their judgment, I believe in giving them the freedom they need to do their job.

Most of my peers in program management think that the most important aspects of our job are making decisions, conducting reviews, and controlling performance. In contrast, I think my priorities are to develop collaborative relations, foster alliances, and take care of the people who work for me, giving them a sense of confidence in themselves. I have to ask, What is going to occupy my time? And for the most part, what occupies my time are people issues.

As I came into program management many years ago, I stumbled into an understanding of this. At first, I gravitated toward an analytical approach because of my background in operations research. I was brought up in the Robert McNamara school of management, where everything is quantifiable—if we can't build a model of something, then it doesn't exist.

It didn't take me long to figure out that this idea was bankrupt. Programs move ahead because of the activities of people, but none of the models I was using measured that. I could do the fanciest calculations in the world, but did they have anything to do with determining whether the project was going to be successful? Not at all. I had some difficulty convincing the people with whom I worked that it was not the right approach, because they, like me, had been brought up to believe that a sharp analytic mind can arrive at a solution for any problem.

Big programs, however, are not predictable. I'm talking about programs that run over many years, cost many millions of dollars, and involve advanced technology. They are unpredictable because outcomes are dependent primarily upon what a lot of individual people are doing.

NINE

TSSAM Lessons Learned

LARRY LAWSON

VICE PRESIDENT

LOCKHEED MARTIN CORPORATION

To fully appreciate Terry's approach on JASSM, you had to understand the TSSAM program. The Air Force decided to terminate the program because they realized it was unaffordable. What I mean by "unaffordable" is that they could not procure the numbers of missiles they needed for the unit price they were facing: \$2 million per copy.

The Air Force hosted TSSAM Lessons Learned meetings for the companies competing on JASSM, and those meetings were a galvanizing event for me. We had the opportunity to speak with the people who had worked on the TSSAM program and, as you can imagine, they were devastated. Lessons weren't conveyed via dry, thick reports, but rather by direct, face-to-face encounters with the very people who had lived it. They wondered why we thought we would succeed. Our challenge was to set aside the emotion and sort out the lessons, both good and bad. The point was to avoid repeating the same mistakes on JASSM.

Some TSSAM Lessons Learned

Management of TSSAM Program funds was fragmented among the three military departments, resulting in an awkward budgeting process, funding shortfalls, and delays in program and contracting decisions.

Source: Federation of American Scientists, “Tri-Service Standoff Attack Missile (TSSAM),” *Military Analysis Network*, February 1998. Accessed at <http://fas.org/man/dod-101/sys/smart/tssam.htm> on 22 October 2004.

I left those meetings and went back to my team, “Look, these are some major things that we have to make sure we don’t do. The real test will be determining what we do.”

TEN

Choose Your Battles

LYNDA RUTLEDGE

SYSTEMS ENGINEER

U.S. AIR FORCE

We had done a draft of the Single Acquisition Management Plan (SAMP) in the fall of 1995. The SAMP is the document that lays out how you will manage a program. It’s a project plan, basically, and it seems as though everybody in the OSD gets to comment on it—and needs to sign off on it.

Terry read what we had written before he arrived and thought the document was, as he put it, “a piece of junk.” I remember him closing his office door and disappearing for about five days to rewrite it. I had known Terry for about a month at this point, and this impressed me more than anything else about him.

I’d never seen, or even heard of, a program director writing his own SAMP. Normally they farmed it out to their leads, and consequently all the SAMPs I’d read before sounded as though they were written by isolated individuals who had no idea how their piece would be integrated into the whole. Terry wanted to present a concise, unified vision. He felt that the quickest way to get there was to do it himself, because he saw himself as the program integrator.

At the same time, he didn’t shut everyone else out. Occasionally he would pop out of his office and show up at people’s desks, like mine, and ask something like, “How many targets do we have?” I would give him an answer and he’d roll that around in his head for a few moments, and then ask a few more questions. Eventually, he would get up, go back to his office, and start typing again. When he was

done, I think he rewrote 90 percent of our original draft, and cut the size of it down by more than half, to about 20 pages.

When the document came back from the OSD, it had grown bigger than he wanted. Everybody has his own little rice bowl. You know how that goes: “This paragraph that talks about what kind of reporting you’re going to get, well, I think you need to be a little bit more specific here.” That sort of thing. Terry didn’t want a lot of detail. He doesn’t believe you need to, or for that matter can, spell out every detail about a program at its start. He pushed back on OSD, but decided to give in ultimately.

One thing about Terry Little is that he knows when to pick his battles. In a case like this, you can’t do anything more than push and push against the system, and in the end it’s going to be a Pyrrhic victory at best if it distracts you from the main task at hand—getting on contract. He was not going to fall on his sword over a handful of paper.

ELEVEN

Caution

LARRY LAWSON

VICE PRESIDENT

LOCKHEED MARTIN CORPORATION

Before acquisition reform, the government said to its contractors, “Follow these military standards and everything will be okay.” From a contractor’s point of view, that was a comfortable place to be. You knew what the government wanted and we also understood our complementary approach to development.

Contractors understood the “old way” of business. There was more time, less risk, and more money. Terry Little was quick to say, “We don’t have the time, we don’t have the funds, and we don’t have the answers. You have the freedom to put together your approach that meets our three key performance parameters, and a warranty to back up the quality of your approach. The objective is dramatic reduction in acquisition time and funds. You either understand that or you are out of the game.”

Terry took a very aggressive approach on standards. He told me, “Larry, throw all the standards out. You don’t have to follow them. I don’t want you to reference a single military standard.” This was an extreme approach to force change—the type of change that was required if we were going to make unprecedented inroads in cutting the time required to field weapons. Suddenly we found ourselves in an environment where our customer was saying, “If you want to win, you can’t do things the old way.”

We went forward with the vision to create a significantly different model for the missile design, system test, subcontracting, and production. Change would occur more slowly in some areas. I think the first place we realized this was in the

New Acquisition Process Being Used

The JASSM Single Acquisition Management Plan has an overriding theme of affordability. To provide the required capability at an affordable cost, the Air Force plans to use a series of new acquisition processes and encourage industry to use commercial practices to lower the missile's price and speed its deployment.

The use of commercial practices has been stressed to all potential JASSM developers. These initiatives are intended to lower development, production, and operational support costs, as well as reduce the time needed to develop and produce the system.

Source: General Accounting Office, *Precision-Guided Munitions: Acquisition Plans for the Joint Air-to-Surface Standoff Missile* (Washington, DC: GPO, GAO/NSIAD-96-144, 28 June 1996), p. 7.

area of safety. When it came to the safety of the war fighters, it turned out that changing the way business was done would be more time consuming than simply complying. I'm not implying that the safety folks didn't try to innovate. Safety is a difficult place to experiment. After all, human life is at risk here. The consequence of failure is dramatic.

We realized early on that we were being too aggressive in our approach in this case, and that allowed us minimize the impact. Looking to place blame for the cost and schedule impacts could have split our team, but we took our lumps and moved on. As a contractor, it is sometimes frustrating when you are moving down an acquisition reform path only to find out that it isn't possible. We were in a purely experimental space. That is a disconcerting place to be at times. Of course change is seldom comfortable.

TWELVE

Credibility

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

There was a Colonel that I worked with when I was a young program manager. I had given him a briefing at the Pentagon and had gotten approval to start a program. Some weeks later, when we were going through new charts, he honed in on one, studied it for a while, and then said, "When you were up here last time did you have this chart?"

And I said, "Well, no—not exactly. I changed this a little bit because after I showed it to you, I got back to Florida (Eglin Air Force Base) and we got to talk-

“The most important thing a project manager needs if he is to get his way or accomplish his goal is his credibility. I was fortunate to have had opportunities over a number of years to establish my credibility with my senior leadership. I went to the people who had given me this job, and what I essentially told them was, You gave me a job to do, and now here’s your part. I’m asking you to take it on faith that I know what I’m doing. I don’t have the time, the energy, or the will to go through a lot of explanations about all the things in my head. You are going to have to trust me on this. And they did—because I had a reputation of being a make-it-happen person, someone who produced results.”

—Terry Little

ing about it, and we decided we should do a couple more tests. Overall, nothing has changed. It’s the same amount of money, it’s the same amount of time, and the same end result.”

So he said, “I want you in my office on Monday morning, and I want you to bring this chart.”

I showed up in his office, this was in Washington, and we got on the DC Metrorail and went over to Capitol Hill where we ended up in a small conference room. Two Senators and four Congressman showed up—not their staff, but the real thing.

The Colonel said to me, “Show them the chart that you showed me, and then show them the old chart.” I did this and explained the change to them, and they nodded their heads with a glazed look in their eyes. The whole episode lasted about five minutes.

We went back to his office afterwards and he said, “I know you’re wondering why we just went through this exercise.”

“Yeah, I am.”

“Credibility,” he said. “When I went over there and got money from them, I showed that original chart. When that changed, I had to go back to them.”

I got to thinking about this and said, “Well, I guess I’m less sensitive to change than that. If it were a significant change, then maybe I would feel obliged to go back to talk to them.”

“What’s significant?” he asked. “Because my confidence in you rests on an assumption that my definition of significance and yours are the same.”

And that was a valuable lesson to me, for a couple of reasons. First, it demonstrated the importance of maintaining credibility with the people that you depend on for the support you need. These Congressmen and Senators didn’t give a damn about this minor change—they really didn’t. He just wanted them to see that they could count on him to be forthcoming and straight. He had been there four weeks earlier, he had shown them something, and they had approved it and

said, “Okay, we will give you this many million dollars.” Now within a month something had changed, not significantly, but he felt—and, in retrospect, I think he was right—it had changed enough that he had to go back.

It wasn’t a case of his being critical of me because I had changed something. He understood why that was necessary because a manager has to constantly look at the schedule, look at: What am I doing? What’s out in front of me? What things might I need to add? What things might I need to take away? How can I reduce the risk? How can I develop alternative courses? It wasn’t that, but rather: I need the people I depend on to support me and believe that they can trust me absolutely. And I need to behave in a way that gives them no doubt, no reason to doubt that’s true.

Given the choice, I want to communicate more rather than less, and I want to behave in a way that leads the people whom I depend on to give me support. I don’t want them to question whether or not they can trust me.

THIRTEEN

Just Like Buying a Car

BRIAN RUTLEDGE

FINANCIAL MANAGER/PROGRAM MANAGER

U.S. AIR FORCE

Before you can go forward with your program beyond the solicitation, you have to get the blessing of the Office of the Secretary of Defense (OSD), specifically the Cost Analysis Improvement Group (CAIG)—they’re the cops of the cost world. They’re very conservative about what they think the costs are going to be, and they are there to challenge your assumptions.

The head cop at the CAIG was the one who had to sign off on the program, and he was known for grilling people hard about how they put together their cost estimates. What I did was invite one of his deputies to work directly with my cost team. I had him interfacing with all of our engineers and anybody we were working with to help build the cost estimate. My hope was that by making him a member of our team, rather than an adversary with whom we had to struggle to get the program going, he would feel accountable for the product.

To invite him in was a risk because I couldn’t control what he was going to see, but I had worked on other programs before JASSM, and I knew that the worst thing you could have happen was for someone on the CAIG to say, “I don’t understand all your data or where your numbers are coming from.”

Even though he was doing an independent estimate in parallel, he knew our data was good because we shared all of it with him. He, in turn, went to his boss and said, “They have credible numbers.”

We presented the CAIG with two estimates—take your pick: the Cadillac or the Chevrolet. You want these kinds of capabilities, it’s going to be this much. You

want less, it costs less. The Cadillac version was around \$700,000 per copy. The Chevrolet was \$450,000. The CAIG had never seen a cruise missile for prices like this. Remember, this was coming on the heels of the TSSAM debacle, where the cost of the missile had ballooned to \$1.6 million per copy.

In the end, the CAIG never challenged our estimates. They simply said that our costs appeared accurate.

FOURTEEN

TSSAM: Redux

LARRY LAWSON

VICE PRESIDENT

LOCKHEED MARTIN CORPORATION

Early on, the Air Force struggled with the classification level of the program. JASSM was a stealth missile, and stealth programs were normally highly classified. A high classification level is an expensive proposition for large programs. It forces the government and the contractor to put extensive controls on facilities, people, materials, and suppliers. It was the first big challenge in demonstrating the Air Force's resolve to address processes that were once considered sacrosanct, to push on the system to obtain the necessary level of security while working affordably.

TSSAM security came at a substantial cost. If we replicated the same requirements, they would drive the development cost, and production costs even more significantly. Frankly, I thought that this would put the program in jeopardy. It was going to be, once again, too expensive.

The security team that normally focused on enforcement worked with us to address security requirements and costs. Management, manufacturing, engineering, and security personnel had never really collaborated in this way. JASSM achieved the necessary security controls that all parties agreed were sufficient, while addressing the most significant cost impacts. I am not certain that these efforts would have been successful had it not been for the legacy of TSSAM and the recognition that change was essential.

FIFTEEN

Bang for the Buck

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

I held weekly meetings with representatives from each of the five companies competing for the contract, to give them an update on where we stood, what had changed since the last time we spoke, where we were having problems in the

program office, where the requirements stood, and what approvals we still needed to get from my upper management. This lasted for about three months. In some cases, I would show schedules and have some documents to pass around, but for the most part it was just talking. The whole point of it was to establish a dialogue.

After these group meetings, I would meet with each of the five contractors separately. Not to tell them something, but to listen to what they had to say. When they were with the four other competitors, they were all guarded and careful about what they revealed about themselves. Nobody wanted to give away their competitive edge or reveal any weaknesses.

They started out reserved in the one-on-one meetings, but as they saw that I wasn't just doing this for my health or because it was polite, they began to approach these meetings much more seriously. When we sat down together, I would ask, "Give me some feedback. Tell me specifically about this requirement. Does the path we're headed down seem right to you? Is there a requirement—or two or three or four—which you think is not going to be consistent with us getting a low-cost system? What I want to know is: Are we spinning our wheels in some area that we don't really understand, and what are the implications?"

From my point of view, I was trying to learn—as opposed to just trying to squeeze information out of them. They were in a position before the contract award where they could be straight with me. After the contract was awarded, they were going to tell me whatever I wanted to hear. Because we were not there yet, they could tell us that this or that was a dumb requirement. We suggested a requirement, for example, to put this weapon on a number of different kinds of airplanes. A couple of the companies said, "We've looked at that, and we can do that, but it's going to take a really long time to go through all of the engineering details. If we could just start off putting it on one or two planes and get this thing

Goals of systems acquisition in the past included:	Today the emphasis has shifted toward:
Many new systems	Fewer new systems; modified legacy systems
Focus on nuclear warfare	Conventional warfare
Technology-driven systems	Affordability-driven systems
Service-specific programs	Joint programs
Military-unique technology	Commercial and dual-use technology
Technology development	Technology insertion
Source: Department of Defense, Defense Acquisition University; <i>Introduction to Defense Acquisition Management Guide</i> , Fifth Edition (Fort Belvoir, VA: Defense Acquisition University Press, 2001), p. 23.	

built and fielded, and then modify it if we need to, we would be much better off in terms of overall cost, overall schedule, and overall performance. Give us a problem that we can work, and then add this additional scope after that.”

The general view in the government was that this wasn’t the way you should do things at this stage of a program. Once you decide on your requirements, then you call in the contractor and say, “Here is exactly what we are going to do, we’ve got it all figured out, and now it is up to you to go and respond.”

I didn’t believe that was the way to get the most bang for the buck. I wanted the five companies who were going to bid to be involved in the process of refining the requirements. Since they were the ones who had to respond to whatever innovations we pitched, it didn’t seem to me to be in their best interest—or ours—to say, “Okay, this is what we’re going to do, and you companies are going to learn how to adjust.” I thought the best way to improve our chances of getting a quality product was to allow for some give-and-take at this stage when our vision for the missile was still in flux.

We sometimes have a problem in DOD in that we establish a requirement without understanding: What does it really mean to try and satisfy that requirement? Until you understand the implications of what you are asking for, in terms of what it costs and how it affects schedule, it can’t possibly be a firm requirement, because you may not be able to afford it, or you may not want to wait as long as it takes to get it done. The fact of the matter is that most requirements are just things someone made up. It starts off as somebody’s opinion or view of what would be good; but what often happens is that everybody then begins to march as if it’s a law of nature that you’ve got to meet this requirement. However much time it takes, and however much money it takes, it doesn’t matter because the requirement is the requirement.

“One of the major reasons for schedule slippages is uncontrolled requirements growth. In some cases, requirements growth is a fact of life. The manager may just have to accept this growth, but, all things being equal, added work should equal a longer schedule. Too often I see managers who agree to adding work without either increasing the time or money to do the work. In effect, this makes adding requirements seem “free.” It is bad business and can turn a realistic schedule and budget into wishful thinking. I have found it useful—and this doesn’t come easy to me—to create a very bureaucratic process for changing requirements. Basically, I say there will be no changes in requirements until (1) decisionmakers understand the cost and schedule implications of the change, and (2) decisionmakers explicitly agree to those implications. It is quite amazing to see how a process that simply establishes accountability for requirements growth promotes better discipline and yields more realistic schedules.”

—Terry Little

Once a requirement is established and everyone has signed on to it, the requirement becomes an expectation, and it is very, very difficult to change. So it is much easier and much better to think about requirements carefully before we formulate them.

SIXTEEN

Starting With a Clean Sheet

LARRY LAWSON

VICE PRESIDENT

LOCKHEED MARTIN CORPORATION

During our first reviews with Terry, he said, “This is what’s important to us. We want a missile in half the time for half the price. We have three key performance parameters: system effectiveness, range, and carrier operability. These things are not tradable; everything else is. You will have the freedom to offer a solution without meeting our standards or detailed specifications. Along with that solution, we will ask for a long-term, bumper-to-bumper warranty to ensure that the methods you choose will be backed up with a quality product.”

Most of our competitors were trying to repackage existing products. We were not known as a cruise missile producer, so most of our team wasn’t burdened with pre-conceptions of how solve this problem. Using the customer’s overarching vision, we opened our eyes to all possible methods, which allowed us to synthesize the design that stands today. The folks that couldn’t get the vision moved on. Those who remained understood the Air Force vision, and shaped our own. We were fortunate to have some of the most innovative folks from our Missiles Division, the Skunk Works, and our subcontractor teams.

Frankly, we recognized at the start that we had to dramatically reduce cost and keep the performance bar high. Substantial erosion in performance to reduce cost would not have the support of the war fighters. A fully integrated systems design approach to meet performance at the defined cost targets was our only hope. System performance was addressed as an integrated product, not as individual stove-piped disciplines. Using the government-defined system capabilities, trades were performed against individual subsystem specifications to obtain a reliable and affordable solution. For instance, it was understood that cruise missiles were built in sections and then integrated in final assembly. That approach wasn’t affordable, and didn’t contribute in any way to performance. We decided on a uni-body approach, which reduced material cost and assembly labor, and we were not going to build the missile fuselage out of metal. We said, “We’re going to build it out of composites, and we’re going to use boating industry processes.” These are only a few of the things that we did to make significant reductions in cost and meet aggressive performance objectives.

From my perspective, even though we at Lockheed Martin faced the challenge of not having a platform to start with, we were in a better position of being responsive to the government's objectives. Success was realized by creative, highly motivated people who were not locked down by preconceptions defined in military standards or captive to accepted thinking and solutions.

SEVENTEEN

Goofy Pictures

BRIAN RUTLEDGE

FINANCIAL MANAGER/PROGRAM MANAGER

U.S. AIR FORCE

After Terry said we were going to be on contract in six months, he directed someone to make a viewgraph stating this goal: Be on contract by 1 July 1996. That was it. He wanted it pinned up in everybody's cubicle. At first I thought: Oh man, this is goofy. I know what we're doing. I don't need to have a reminder on the wall.

When I talked to other people working in the program office I just rolled my eyes. "What's this guy thinking?" I said. "It's like we're in kindergarten."

After a few months, however, I had to admit that there was something to this. I saw it there everyday when I walked up to my desk. I eventually found myself stopping to think: What am I doing to get to that point, and what can I cut out of my work that's preventing me from getting there?

Whenever people took me down a rabbit trail and I started to follow them a little bit, I looked at that stupid chart and said to myself: Hold on. Am I getting distracted from this?

"An early focus on manufacturing was a key part of our program's design phase. In order to find low-cost solutions and strategies that addressed manufacturing costs before production, that's the way it had to be done."

—Terry Little

EIGHTEEN

Male Chauvinism or Old School?

LYNDA RUTLEDGE

SYSTEMS ENGINEER

U.S. AIR FORCE

Terry gives women more latitude than he does men, and I took him to task for it once, much to his chagrin I think. A woman in a leadership position on our team was vanishing for long periods without any explanation. One day Terry asked me, because he knew I had the most contact with her, if I thought her absence was having a negative effect on the program. I told him that I thought it was.

Then he asked me what I would do. So I told him, "I'd get rid of her." I said it wasn't worth sacrificing the morale of the rest of the team to keep her on. The program was a roller coaster ride as it was, and it was bad for morale when someone whom you relied on to make decisions was disappearing for long stretches and holding people back.

"But technically she's good," he said.

"When she's here," I pointed out.

"Well, I just like to give women more latitude," he explained.

That's when I told him, "You're a male chauvinist." I could tell he was mortified.

"What do you mean?" he asked.

"You treat women differently than men," I said. He still wasn't getting it. "We don't want to be treated differently," I said. "What kind of example does that set for junior people when they see somebody senior behaving that way? Is that the example you want to set for future leaders? It's unacceptable. It's just not worth the technical benefit she brings to the program." He listened to me, but he didn't get rid of her, and the problem didn't go away either, as he continued to compensate for her absences.

NINETEEN

Where the Ground Feels Solid Under My Feet

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

Part of a technical requirement has to be cost. Cost is a technical issue, and to treat it as something different is crazy. Imagine a car manufacturer telling its engineers, "Go and design the next generation whatever-kind-of-car, then after it is designed ask, 'Okay, now can we sell it? Is there a market for something that costs this much?'"

Our aim was to demonstrate that we could produce this missile for low cost. What I did was make cost an intrinsic part of the technical requirements for designing the missile. You have to do that kind of thing sometimes to make sure

the engineers understand that the success or failure of their activity depends on what the ultimate cost is. The thing about engineers is that they generally do not accept ownership of cost and schedule; they accept ownership of performance, but cost and schedule are somebody else's problem.

With a cruise missile, there is a critical performance parameter called "radar processing," which essentially has to do with how visible the missile is on radar. Ideally, you would want it to be totally invisible. You can spend infinite amounts of money on this, so you have to decide what you are willing to accept and can still afford. We had engineers who were very eager to go four or five orders of magnitude better on this parameter. Then there were the cost people saying, "We don't need to be any better than the predecessor program. We don't want to reach for something and spend a lot of money and then not make it. Let's stay on ground that we know will not collapse beneath us."

In this case, we had an opportunity to set the performance parameter to what we knew for certain we could achieve, because of a predecessor program (TSSAM). We could have set it at that number and been virtually guaranteed that we could do it, but that kind of expectation communicates an unwillingness to take risk or tread on any ground that has not been covered before. The way I saw it, the question was: How much better should we go?

Ultimately, what I decided was somewhere in between the engineers and the cost people. Did I have a basis for that? No, but it seemed like we ought to be able to do better than we did two or three years ago, because of improvements in certain technologies. The engineers whined that I wasn't being ambitious or aggressive enough; the bean counters whined about the risk. Nobody was really happy. In the end, it turned out to be a good match of cost and performance.

"One thing I will tell you about Terry Little. If you do a good job for him, and he knows that you're loyal to him, he will support you to the n th degree. He doesn't care if you make a mistake, he doesn't care if he doesn't agree with something you did: he will support you until the day he dies."

—Jackie Leitzel

Cost as an Independent Variable (CAIV) is establishing the affordable price for a system and then trading off either performance or schedule to meet that price. The trick is to define performance . . . in a way that permits the Program Manager and industry to meet the warfighter's real requirements within the constraints of affordability.

Operating under the CAIV concept, the PM (Program Manager) can trade off performance for cost as long as the Key Performance Parameters (those requirements that the Program Manager may not trade off) are met. This means that every opportunity to reduce cost without affecting the KPPs can be made at the program level.

KPPs for the Joint Air-to-Surface Standoff Missile (JASSM) are but three: minimum acceptable maximum missile range, mission effectiveness, and aircraft carrier's suitability. While these are very broad requirements, encompassing many lower-level requirements, they are exactly what facilitates CAIV—broad statements of need that can be satisfied in a wide range of ways with a number of potentially radically different designs.

Source: Capt. Guy Higgins, USN, "CAIV—an Important Principle of Acquisition Reform," *Program Management* (Defense Acquisition University), January-February 1997, p. 45.

TWENTY

What Is It That You Need to Know?

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

The question I put to the people working in the JASSM program office was this, "What do you absolutely need to know before you can decide which two companies are going to go forward on this contract? Forget about what's nice to know. What are the things that we absolutely must have from them?"

On the first cut, everybody got to say what was essential. The Chief Engineer laid out what was essential to his staff, the Finance director read off his list, then we heard from Logistics—and so on down the line. We went through this hierarchically, and after the first cut there was an enormous body of requests that would have produced a 1,000-page proposal.

On the next cut, I had the same people stand up in front of me, and I asked them, "Why are you going to make five companies spend the money and energy to give this information to you? Tell me why this is essential for making this decision?"

When they had it put to them this bluntly, some of them just said, "Now that you put it that way, I really don't have to have it. I would like to have it, it would be nice to have, but do I have to have it? No."

When all was said and done, we had cut a 1,000-page proposal down to what I felt could be adequately addressed in a 4 hour oral presentation.

TWENTY-ONE

Oral Presentations

LYNDA RUTLEDGE
SYSTEMS ENGINEER
U.S. AIR FORCE

Many people in the government don't want to talk to contractors prior to source selection. They think we should write an all-encompassing Request for Proposal, hand it over to contractors, get an all-encompassing document back, and then go read the thing in our hole and say, "We pick you."

Personally, I think it's absurd to choose a contractor without talking to them and finding out who they are, what their strengths are, and how you're going to team with them. Let's face it, a contract is like a marriage, and to do that sight unseen, I mean, I just think that a decision worth billions of dollars should not rely on pieces of paper.

Terry fought to change that way of doing source selection. He wanted the companies to do oral presentations instead of simply turning in a written proposal. Although we did have the oral presentations, he didn't entirely get his way. Upper management worried about our ability to evaluate live performances, and the companies argued that scheduling the presentations on different days meant that some of them would have more time to prepare than others. In the end, the compromise was to have them all turn in videotaped presentations at the same time. Unfortunately, that defeated the whole purpose of doing an oral presentation, because we missed out on the dialogue.

Nobody was more anxious about the oral presentations than the companies who were doing them. They worried that their engineers weren't going to be effective presenters, or that one might go off on a tangent and never come home. They got nervous after the dry runs, which were face-to-face with government evaluators. There was plenty of dialogue then. We raised hands, asked questions, and cut in. We had the ability to say to our counterparts on the contractor side, "Hey, I don't get what you're saying . . . I've never heard this before . . . I don't understand what you're talking about." And then they would respond back, "Well, the reason we are doing it this way is . . ." That was invaluable, and that's what you really need to do in order to evaluate and understand somebody's proposal.

When we got the final presentation tapes, some of the contractors had hired professional actors to narrate. In other cases, the companies' engineers, bless their hearts, gave acting a shot. I wasn't the only person who considered the videotaped presentations a waste of time. The companies all submitted written slides to accompany their presentations, and most of us who were doing the evaluations turned off the tapes and did our evaluations based on the slides.

Navy Commitment Uncertain

JASSM is to be designed for use at sea, but no Navy funds are committed to its development, no requirement exists to integrate the missile with the Navy's F/A-18 aircraft during development, and no Navy missiles are included in the planned production quantity

For JASSM to be carried on, stored within, and launched from an aircraft carrier or other ship, it must meet Navy environmental and supportability requirements. These requirements are significantly more demanding than those for a land-based missile system. They must be designed into the missile system. Adding them later, according to the program office, would require a basic redesign of the system and a production block change.

Source: General Accounting Office, *Precision-Guided Munitions: Acquisition Plans for the Joint Air-to-Surface Standoff Missile* (Washington, DC: GPO, GAO/NSIAD-96-144, 28 June 1996), p. 13.

TWENTY-TWO

Smoking

BRIAN RUTLEDGE

FINANCIAL MANAGER/PROGRAM MANAGER

U.S. AIR FORCE

Our plan called for completing the source selection in three weeks. Three weeks to review the proposals and choose the two companies who would compete for the next two years. Three weeks, and then breathe.

I had one person helping me to crunch numbers. When I recruited him, he wasn't in high demand. In fact, a lot of people around Eglin Air Force Base thought he was off the wall—and he was. He was definitely high maintenance, but he was intelligent, and had a passion for what he did. If you ask me, those two things can overcome just about anything.

All he needed was a little direction, so I kept him focused on which way to go. He loved the intensity, and we worked insane hours during those three weeks. The only thing that slowed us down was his chain smoking. We'd be the only ones in the building at 11:00 at night and he'd be smoking like a fiend. Each time he lit up, he had to leave the office and go outside the building. Finally, I said, "You're not leaving! Open the window and smoke. I'll take the heat for it."

The person who managed the building complained, “We’re going to throw you out of here if you keep this up.” Fortunately, the source selection was done before he could mobilize the bureaucracy against us.

Other people would never have considered recruiting this guy for their team, but I knew he would get the job done. You have to get the right people for the job at the right time. After source selection, I moved him around to work other budget issues so that he was more promotable (and he got promoted), but I suspect that he never enjoyed himself as much as he did those three weeks during source selection. The room reeked of cigarettes, but we got the job done.

TWENTY-THREE

Six Is Not Seven

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

The truth is that I pulled the number “six” out of my hat. I would have been happy to be on contract at the end of seven months, or even eight months, but I would never have told the team that.

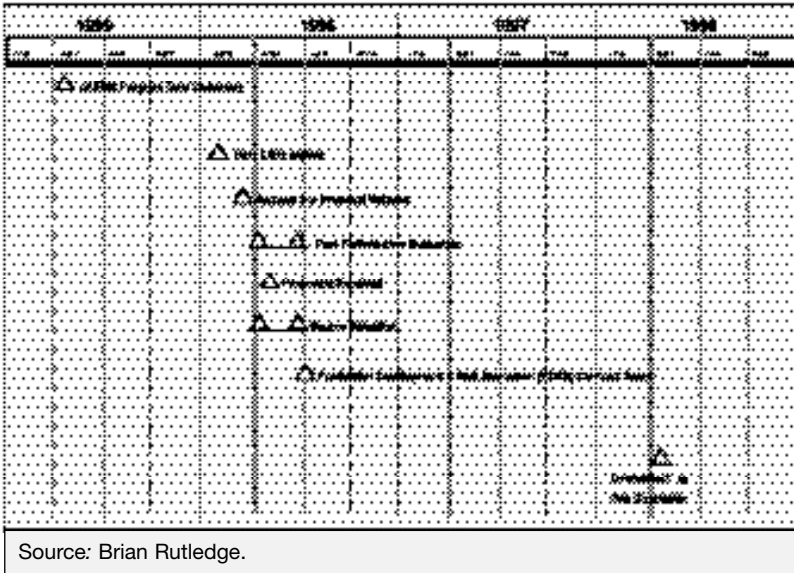
What I wanted to do was set something that would challenge these folks to look at things in an entirely new way. I didn’t want a schedule that they felt they could achieve just by working on weekends or figuring out a handful of inventive ways to do things. I wanted something so outrageous that it would cause them, first, to essentially give up, but then—once they figured out that giving up wasn’t an option—to step back and examine all their assumptions, all their beliefs, all the things that were in their heads as a result of their experiences and what they had been told in the past, and to ask themselves with a clean slate: What do I really need to do to achieve this goal?

As they ran into hard times, they wanted to negotiate. There were a lot of people saying, “Hey, we’ve figured out ways to work faster, but does it really have to be six months, or can it be seven?”

“No,” I said, “because the difference between six months and seven months is that seven months isn’t the goal.”

What we achieved was something even better than six months. At the end of the day, we completed the source selection in less than five months. People were proud of themselves, and with good cause. Problems didn’t remain unsolved for long. People no longer scratched their heads and asked one another, “How should we make the right decision?” Now, there was a commitment that anything that was a problem had to be attacked with a sledgehammer. The team addressed all problems, no matter whose area it was in. They wouldn’t let any problem cause the rest of the team to fail. When a problem was detected, everybody marshaled

JASSM Timeline



their energies together to try and figure out quickly, How do we move forward? How do we solve the problem? or, How do we get around this problem?

Even after they got to the point where it became fairly certain that they were going to meet the six months, they were so imbued with energy and passion for achieving the goal that instead of saying, “Okay, now let’s coast,” they kept working on it, and every day were still trying to figure out, How can we cut another day, another two days, another three days? What is it that we’ve got in front of us that we need to do, and is there a quicker way to do that?

We kept a chart to measure our progress. It wasn’t a chart to mark off this event, that event, and so on. Forget about chronology, it was a chart that graphed how much we had accomplished and how much we had left to do. Some days we put our progress at 70 percent, and the next week, having run into some kind of unanticipated problem, our mark would go back down to 60 percent. People would look at that and say, “Oh my god, we’ve got to step it up!”

When we talked about it afterwards, what the team discovered was that they hadn’t known how capable they could be if they just quit thinking about things in the way they had always thought about them. They achieved what they did as a result of passion, commitment, and focus, as opposed to being smart, making good decisions, following the rules, and making sure they didn’t make any mistakes.

TWENTY-FOUR

Straight from the Boss

LYNDA RUTLEDGE

SYSTEMS ENGINEER

U.S. AIR FORCE

After we awarded the contract, one of the companies protested a decision I had made during the source selection. We went through a quasi-legal procedure with the General Accounting Office, complete with formal hearings where we testified under oath. I had already finished my testimony, and I was working at my desk one day when Terry came over and sat down with me.

I was on edge since I'd been called to testify, and I think that he could see that. "There's something I want you to remember," he said. "One of your virtues is that you're willing to take risks and make a decision and move forward. You get things done, and I don't want this episode to taint that or make you afraid to do things." He said this same thing had happened on one of his earlier programs. Someone he admired for her energy and determination had to face a protest in her area. She never got over it, he told me.

A lot of bosses talk the talk about letting you take risks, but when something goes wrong, they punish you. Not Terry; he's not afraid to fail, and that's why he takes chances. "This is a good experience for you," he said to me, "you're going to learn so much from this." His sitting down with me and saying these things restored my self-confidence. As it turned out, the protest was not sustained. Over the long run, the memory of that experience encouraged me to be willing to stick my neck out again and again.

The Sky Is Falling—or Maybe It Isn't

"Some people in the JASSM program office didn't think we'd get a protest, but I felt all along we would, and past performance would be what it was over, which it was. Nobody had ever put as much emphasis as we did on past performance during a source selection. For most government people, a protest means the sky is falling. My bosses in the contracting office at Eglin were very nervous about this emphasis on past performance. With anything new or untried, you can usually find a lot of loopholes and ways to poke holes in it. "How are you going to win a protest if this has never been tried before and you don't have any precedent?" They always worry about precedence. Terry's position on that was if we're probably going to get a protest anyway, it really doesn't matter whether or not they're worried."

—Jackie Leitzel

TWENTY-FIVE

Don't Ask, Don't Learn

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

The best indicator of how someone is going to do in the future is not what they say in a proposal—it is how they have done in the past. It is one thing to say you can do something, and it's quite another to be able to deliver on it.

Normally the way we (the government) assessed a company's capabilities was to ask them to put it in their project plans: How are you going to do systems engineering? How are you going to do financial management? How are you going to do your project management? How are you going to control cost and schedule? Companies aren't stupid. They hire people who know the right things to say in a project plan.

Before we told these companies the details of what we wanted them to propose, we evaluated their past performance. After the contract award, one of the companies who'd lost protested. Let's call it Company X. The essence of the protest was that we had not properly evaluated the company's past performance, that we had assigned a bad rating when, in fact, the company was performing well—very, very well—on the program that we had evaluated.

The government project manager we talked to about Company X's past performance got up on the witness stand and said the same things in front of the lawyers that he had said to us. Company X sat there blinking in disbelief. This hearing was the first time the company had learned what the customer actually thought about the work performed. The interesting thing about all this, to me at least, was the company had never bothered to ask its customer, "Hey, how am I doing?"

Narrowing the Competition

Two defense contractors were chosen to compete in the program definition and risk reduction phase of the Joint Air-to-Surface Standoff Missile program on June 17, 1996. The contractors, Lockheed-Martin Integrated Systems of Orlando, Florida, and McDonnell Douglas Aerospace of St. Louis, Missouri, were announced at a Pentagon press briefing by Arthur Money, assistant secretary of the Air Force for acquisition. The companies were awarded cost-plus, fixed-fee contracts totaling \$237.4 million, and will compete in head-to-head competition over the next 24 months. At the end of this phase, the Department of Defense will select one of the contractors to complete development and production of at least 2,400 JASSMs at a total program cost of approximately \$3 billion.

Source: "Competing JASSM Contractors Chosen," *Air Force News*, accessed at http://www.fas.org/man/dod-101/sys/smart/docs/n19960619_960587.htm on 12 June 2003.

TWENTY-SIX

Mr. Government Man, Can You Lend a Helping Hand?

BRIAN RUTLEDGE

FINANCIAL MANAGER/PROGRAM MANAGER

U.S. AIR FORCE

When we down-selected from five companies to two, I switched from being the financial lead in the government program office to being program manager on a helper team for one of the companies, McDonnell Douglas. I stayed in this position for the duration of the competition, which lasted two years. A little more than a year into the competition, McDonnell Douglas merged with Boeing, and our program office was absorbed into the Boeing organization.

The role of a helper team was to assist your company in winning the contract at the end of the two years. When we began, six government people were assigned to each of the helper teams. We all came from the JASSM program office at Eglin Air Force Base. Winning was the goal. Forget about the old goal of getting on contract in six months. We had a new goal.

I spent about half my time between Eglin in Florida and the company's main facility in St. Louis. The vice president at McDonnell Douglas/Boeing in charge of JASSM came to me and said, "We need you here working directly with our suppliers, but we also need you to go back and help influence the down-select team." Soon after we moved into our offices in St. Louis, Terry asked the vice president whether he wanted to reconsider having government helpers. I took his answer to mean that we had passed muster. "Oh no, I want to continue this," he said, "these people are integral in helping us make decisions." And we were. He often asked for my advice on how we should present this or that problem to the government team back home. When I sat in on meetings with suppliers, I heard all of the cost details, and he didn't seem to worry that I was hearing that kind of information.

When I was with the government team, my job was to show why my company earned an "A" grade on the evaluation criteria. At this point, you could say I might as well have been wearing a company uniform. For example, the first time Lockheed Martin dropped their missile off an F-16, it almost took the wing off the plane. This was important news because McDonnell Douglas/Boeing had made changes to its design to show that their missile could safely separate from the aircraft. Originally, they had placed three fins on the back of their missile, then they added a fourth. This cost more money, but improved reliability. I worked hard to convince the government down-select team that the fourth fin was a huge benefit—and I didn't hesitate to bring up the problems Lockheed was having. "I heard it almost took the wing off. A missile can't accomplish anything unless you can demonstrate that it falls off an airplane safely."

Winning was everything. Naturally, I couldn't do anything illegal, but all else was fair game. I'll say this, it was the best job I ever had working for the government in terms of having a clear direction.

TWENTY-SEVEN

What is Help?

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

I picked the helpers. Their job was to support their respective company—not to look after the government’s interest, not to make sure the company didn’t do something stupid, not to bring home secrets to me—just to help that company win, period. And the reason that was in the government’s interest was because at the end of the two years we wanted to face a difficult decision when we selected the winning company.

The government’s role should be to ensure the success of the project, and the way to do that was not to oversee or second-guess the contractor—the way to do that was by helping the contractor. Help the contractor to do things that the contractor can’t do or that the government can do better.

The helper teams set the stage for what I wanted the government’s role to be two years later when we got down to one contractor. When we finally got down to the one company that was going to do the job, I wanted to have already established a working relationship in which we were open, straight, candid, and—most of all—trusting of one another. I clearly understood that you can’t do that by just saying it is so. It just doesn’t work that way.

Now there were a lot of people above me who were against this. Their view was, “The guy who loses will protest or create a legal problem for us because he will argue that you gave him weak people or that his competitive position got inadvertently disclosed by these government people.”

The companies had the ability to get rid of any government person they wanted to at any time for any reason. In other words, the company was the one that decided what “help” was and whether or not they were getting it. If they thought they needed someone else with a different talent or expertise, I would do whatever I could to get it for them.

The principle [sic] focus of the 24-month competition is to eliminate unnecessary cost and allow the contractors to trade off performance and other requirements.

During the competition, the Air Force intends to use its new management strategies to address schedule and cost risks before advancing into the final development, testing, and initial production phases.

Source: General Accounting Office, *Precision-Guided Munitions: Acquisition Plans for the Joint Air-to-Surface Standoff Missile* (Washington, DC: GPO, GAO/NSIAD-96-144, 28 June 1996) p. 6.

TWENTY-EIGHT

Rolling Downselects

BRIAN RUTLEDGE

FINANCIAL MANAGER/PROGRAM MANAGER

U.S. AIR FORCE

Every six months, the two companies put together a briefing to explain to the government how we scored ourselves against all the downselect criteria. These were called the rolling downselects, and they were like the source selections all over again.

For two days every six months, we went through the entire design so that the government understood how it related back to the downselect criteria. The government evaluators asked questions, which was part of the purpose. The government did their evaluation and presented it back to us and to the Office of the Secretary of Defense (OSD) in Washington.

What was unique about JASSM was that we let the companies decide what they were going to do during the two years. We didn't present to them a statement of work and say you have to do A, B, C, D and E. Because they were at different stages of maturity in what they had, we gave them the opportunity to tailor what it was they were going to do in the next two years, and said we would judge them on that.

At the end of the two years, we would pick the one whom we believed was best able to carry us on through the rest of the program. We let the competition give us the assurance that we were going to get good value for the money.

TWENTY-NINE

Look Who's Helping Whom?

LARRY LAWSON

VICE PRESIDENT

LOCKHEED MARTIN CORPORATION

The government helpers were an integral part of our team, giving us know-how and insight into the program office as well as other agencies. They were highly motivated and influential. Terry told me, "At any time, you can pick up the phone and request different helpers." It set a tone that conveyed that this was a team in which all members were accountable. I was very happy with the group of helpers we had, and was actually encouraged when the helpers approached me with problems either technical, programmatic, or with our team. While removing one of the helpers was an option, I would not have considered it unless no other solution was possible. To dismiss one of the helpers would risk alienating the entire government team.

Although the helpers became critical members of our team, I believe the source selection team probably benefited more from the helpers than we (the contractors) did. What Terry got back from these folks was an insider's perspective on what was going on inside the contractor's facilities: Was the contractor team competent? Where were their weaknesses? Where were their strengths? Which team was leading? Keeping tabs on the helpers wasn't just something he did to stay interested in the program for two years during the rolling downselect. He would be getting married to the winner, and he was able to see whether this was an organization he could work with.

Let me give you an example of how Terry kept tabs on us. I remember getting a phone call one day from Eglin and being told that two gentlemen from his test organization were showing up next day. We were "red on the proposed test program" they said. That was a surprise to us. Still, my response was to welcome them into our facility. "When can we meet?" I asked. My view is that dialog with the customer is the most valuable part of the rolling downselect process for the government and contractors.

The government people showed up the next day, and they were quite serious. They expressed their concerns, and we talked about the program. I spent the whole day with them. When all was said and done, we didn't change the test program much. We did move around a couple of people. Ineffective communication had caused most of our problems. It wasn't that our testing lead was incompetent. On the contrary, he had a long track record as a demonstrated tester and was very confident. We had plenty of talented people, but what we needed were people who were also able to communicate with our customers. Why argue when the real issue was less about the details of the test program and more about the relationships between the people? We didn't have a good working relationship there, and we made the changes we needed to make.

Being willing to fix things as opposed to arguing about them is the kind of openness that you ultimately have to have on both sides to make it through the long haul.

Missile systems that most closely approximate the capability expected of JASSM, such as the Navy's Tomahawk and the Standoff Land Attack Missile-Expanded Response (SLAM-ER) missiles, cost significantly more. Others, such as the Air Force's AGM-130 and AGM-142, do not have the range, accuracy, or carrier flexibility required for JASSM, yet they cost about the same as the JASSM threshold price or more. Also, none of these missiles has the lifetime, full-service warranty planned for JASSM.

Source: General Accounting Office, *Precision-Guided Munitions: Acquisition Plans for the Joint Air-to-Surface Standoff Missile* (Washington, DC: GPO, GAO/NSIAD-96-144, 28 June 1996) p. 13.

THIRTY

How Low Will You Go?

BRIAN RUTLEDGE

FINANCIAL MANAGER/PROGRAM MANAGER

U.S. AIR FORCE

In the Program Definition and Risk Reduction phase, the affordability of the missile was rated higher than its technical capability. This was no secret. At the end of two years, the government would select a contractor who promised technical competency at a good price. In everything the companies were doing in this phase, they had to work to convince the government that they had gotten the price of this missile down.

As one of the Boeing helpers, I told them where I thought they should be in terms of a production price at the end to win the contract. They had the resources to be very aggressive in pricing the missile. They had built another missile called SLAM for the Navy. Historically, they'd been the cruise missile contractors, and I think they did not take the stance of being aggressive enough on their pricing, and I tried to get them to change. I kept arguing, "That's not good enough to keep the other guy out. The other guy is very hungry and wants to get into the cruise missile business. We need to find some other ways to get this price down lower than he is willing to go."

I could not convince them that they had to be more aggressive in their production pricing, and this was something that frustrated me throughout the process.

THIRTY-ONE

"Not to Worry"

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

I visited one of the contractors' suppliers and asked him to tell me, "What is the prime making you do, or causing you to do, that you think is worthless or not value-added enough to offset the cost?"

A representative from the prime was present, and so there was a little bit of nervousness on the part of the supplier. I told the representative from the prime to go get a cup of coffee. I ended up with about three pages full of stuff that the supplier said was causing him headaches. As I was writing all this down, he asked, "What are you going to do with that?" And I said,

"Not to worry."

I made it clear to him that I was going to protect him, and I think he accepted this. Legally, I couldn't do a thing, and he knew that, but I knew that he would-

n't have told me any of this stuff about the prime if he hadn't believed me. How did I gain his trust?

Well, for one thing, I was there. A government program manager does not normally go to visit the suppliers of a prime contractor. The fact that I was there and willing to spend a whole day looking at his facility, meeting his people, and talking to them about the program and how important their contributions were—that was a big deal to him. A lot of these people never see any government people, except for inspectors, so when I showed up at their facility they understood that it was because I wanted to know about what they were doing.

Typically, the government says, "Our contract is with the prime, and we don't have a contract with these suppliers." Maybe that's true, theoretically, but think about this in terms of common sense. A large part of the success of the program depends on what the suppliers to my contractor are doing. Am I just going to close my eyes to that? We have two big companies putting together a cruise missile, and there are all kinds of smaller companies that provide the engine, the warhead, the fuses, etc. I believe it's important to communicate with everybody that's involved in the outcome of a program.

I understand that I can't go to these suppliers and start making demands, do this, do that, because I don't have an official means, an actual legal relationship with them; but for me to just say, "Well, that's not my problem," or, "I'm not very interested in any of them"—to me that seems insane. Yes, it is true that we can't be in there undermining the relationship between the prime and the suppliers, but it doesn't mean that I can't, for example, as the government program manager, go to some of these key suppliers and say to them, "Tell me what I can do to help you do your job better."

I gave the three pages to the prime without any explanation other than, "This is what he told me." A week later, this guy from the prime came back to me and explained how they'd addressed everything on the list except for one thing, and he gave me a detailed and satisfactory explanation as to why the one thing was still important to do. That was fine. I had no problem with that.

THIRTY-TWO

Watch Out, Granny!

LARRY LAWSON

VICE PRESIDENT

LOCKHEED MARTIN CORPORATION

I remember a meeting shortly after the first-phase source selection where Terry said, "Okay, here's the way it is. We did the last downselect 50 percent on past performance. Now the rules are different. Affordability is going to be foremost.

The contractor who can provide the best price—and is somebody that we can work with—is going to win.”

That was a wake up call to me. I remember realizing that we were going down the wrong road. We were moving ahead with a performance-oriented agenda. We had to change what we were doing and drive everything toward affordability, and we did. One of our engineers was quoted a few months later as saying, “We would shoot granny for a dollar.”

Acquisition reform forced us to take a whole new look at the way we did things. For example, we normally would have built composites at our Skunk Works facility in Palmdale, California. Our Skunk Works facility and team are legendary, but because affordability meant everything, we went with a supplier instead. It would have been lower risk to do it at Palmdale, it would have been superior quality, but it was going to cost us more money.

We found a company outside of Boston that had been in the business of making baseball bats and golf club shafts. They had never built a military product, but they knew how to weave carbon fiber and were open-minded, and we were committed to making them successful. We brought this small company from being a baseball bat provider to being a cruise missile supplier, and it was a remarkable transformation.

I have to give the credit to the folks at Palmdale. In spite of the fact that they were going to lose the work, they found the Boston company for us. They also helped find a supplier for our missile wings. One of the fellows at Palmdale knew about a company that built surfboards. He said, “Hey, look, I think this wing is the same kind of thing that they do with surf boards.” We went down to their factory in a disadvantaged section of Los Angeles and bought the equipment for them. Now they make cruise missile wings using surfboard technology.

We outsourced work any time we realized that we could do something more affordably with suppliers. I won’t deny that there were conflicts within the organization, but we were able to convince people that this was what it took to win.

THIRTY-THREE

Set the Bar High

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

There was a woman who worked for me on JASSM whose husband got cancer. She decided that she couldn’t deal with all the traveling she was doing, so she came to me and asked if I could find something else for her to do. She still wanted to be on the team, but she needed to have another job.

“How about if I make you the financial manager?” I asked.

“I don’t know anything about finance,” she said.

I said, “You know enough and you will learn, and there are some good people there.”

“I’m going to get you in trouble,” she insisted. “We are going to have an audit. I just can’t do it.”

“Yes you can.”

Finally she said, “Okay, I will try it for a couple of months, but I am telling you it is not going to work out.”

At the end of two months, she and I had a little talk and I said, “I’m very happy with the way this is going. You are doing terrific.”

“Well, I’m feeling a little bit more comfortable, but I still don’t think this is my cup of tea.”

After six months she came to me and said, “I love this. I just love it.”

You see, I knew something about this woman that made me feel confident that she was going to rise to the occasion. I knew it was an essential part of her being that she had to excel in whatever job she had. She still had her priorities straight, and she was spending time with her husband, but when I gave her a challenge, she would rather have died than disappointed me.

To a large extent, my experience has been that people are able to adjust their behavior to produce what they perceive is expected from them. If you don’t expect much, not much is what you’ll get. If you expect a lot, you tend to get the best that people can offer, and that’s generally pretty good stuff. I think the key to getting the most out of people, whether they are government people or working on the contractor side, is to have a high expectation for results.

THIRTY-FOUR

“Behave Yourself”

LARRY LAWSON

VICE PRESIDENT

LOCKHEED MARTIN CORPORATION

On TSSAM, you can point to a number of factors as to why the government ended up in a situation where they had a system that was unaffordable, but a primary lesson learned was that there were too many services involved. It was an Air Force-Navy-Army program, with requirements to meet across each service. So when DOD looked at TSSAM to try and understand how best to approach JASSM, the first thing they decided was: Too many cooks in the kitchen is not effective. We have to pick someone to be in the lead.

It was determined that the Air Force would be the lead service on JASSM. Based on their earlier experience, the Navy’s approach then was to sit back and see how things played out. This was one reason why Terry believed the Navy wasn’t fully on board with JASSM, and why he was wasting time addressing special requirements. The insensitive munitions (IM) requirement, for example,

was a huge issue for the Navy. The USS Forrester experienced massive casualties when a warhead blew up and adjacent weapons caught on fire and exploded. An IM cannot have an explosive reaction to fire, an adjacent explosion, or being dropped. That requirement had never been met. We were determined to ensure ultimate Navy participation, and took the same systems approach to meeting the Navy's IM and affordably requirements.

I know that Terry thought we would lose focus by addressing specific Navy requirements. There were times when he called to say, with regard to my discussions with the Navy, "Now behave yourself." When those calls happened, and they would sometimes be adversarial, I would listen and assure him of our resolve to keep our commitments to the Air Force and the Navy. The calls were more a reminder of priorities. Our ability to work through these and many other conflicts helped mature our relationship as we worked to maintain our credibility by meeting our commitments.

Lockheed Martin wanted the Navy to participate in the program, and we were determined not to lose on this point. I don't mean losing to our competition, but losing the opportunity to serve the Navy. In the case of Navy requirements, it cost us a little bit more money to put that capability in a weapon, but I think that in the long haul it was the right thing to do for both the war fighter and the contractor.

THIRTY-FIVE

The Decision

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

When it came to choosing which company would be awarded the contract, we would have liked for it to have been a difficult decision. However, it was not a difficult choice. One company was clearly the stronger of the two.

The one that lost didn't do a bad job. They had good engineers, they used disciplined processes, but when they got feedback from the government, instead of listening to us and looking at what they were doing, they argued— "But you just don't understand." It was as though they had their plan and nothing was going to cause them to deviate from that.

The other company listened to our feedback, and after their reviews would go back and decide, What is it that we need to change? Where is it that we need to put more emphasis? Where is it that we need to get rid of people? Where is it that we need to spend more money? Every time they got feedback, they saw it as an opportunity to adapt. There was no doubt, by the time we got to the last review everybody knew who was going to win.

The company that lost also had another big problem. Eventually they overcame it, but by then it was too late. Their suppliers complained that the prime was

JASSM Mission Statement

To produce and field by 2003 a cruise missile system providing revolutionary combat capability with an average production price less than \$400K (FY95\$) resulting from a successful government -Lockheed Martin-subcontractor teaming relationship—a relationship where the war fighter gets a system that will maintain superb performance with a low cost of ownership over the life of the program, Lockheed Martin and its suppliers get a reasonable profit, and the defense acquisition community gets a model for acquisition reform that others will emulate for years to come.

Source: “Cheaper, Faster, Better in Action,” presented by Terry R. Little at NASA Project Management Knowledge Sharing Session, March 2001. Accessed at http://appl.nasa.gov/pdf/56570main_tlittle_east_west_0301.pdf on 30 September 2004.

unwilling to give them the money to build prototypes. In order for the suppliers to figure out what price they were going to sell something to the prime, they had to figure out, What’s it going to cost me to do it? It took three or four suppliers to essentially say, “Unless you give us the money to do some prototyping, we aren’t going to be able to give you a firm price.”

Let me explain the importance of doing this prototyping. You want an affordable system. Well, part of the approach to getting there is to make some up-front investments. Part of the reason TSSAM was so expensive was because nobody worried about this sort of thing until it was too late. Somebody should have asked, “How do we convince ourselves that we know how to build this in an affordable way?” You do prototyping up front, and then see if something works like you think it will. Sometimes it will, most of the time it won’t, but then you learn from that.

In many respects, that is the best way to learn. Take, for example, the small business in Massachusetts that Lawson’s team subcontracted with to build the composite airframe. The first prototype they built took a long time, and the end product didn’t measure up. When they built the second one, none of their processes had changed, but they had learned what things they didn’t have to do or be concerned about, and so the second prototype was a better product that took about half as long to build. And then they built a third one, and then they built a fourth one, and then they built a fifth one. By the time they built a sixth one, they knew exactly where it was that they had to be concerned with the strength of this thing as they were putting it together, they knew exactly where there was something that needed the operator’s close attention when it was coming together, they knew exactly where it was that they could reduce their cost, and they felt comfortable with the product they were producing.

That is a wonderful way of learning, and we don’t do enough of that because we would like to believe that if we just get enough smart people together, we can

Voice of America Announces JASSM Contract Award

U.S. Defense officials have chosen Lockheed Martin Corporation to build the next generation of stealthy, smart missiles. The more-than-\$2-billion project is supposed to devastate enemies and safeguard aircrews.

The Air Force says it will buy 2,400 of the weapons. The Navy says it is interested, but has not yet agreed to buy the bombs.

Source: "New Missile Correspondent Report," accessed at <http://www.fas.org/man/dod-101/sys/smart/980409-jassm.htm> on 2 November 2004. (Report based on Voice of America broadcast, 9 April 1998, 6:48 p.m. EDT.)

just run through the numbers, put them in the model, do the simulation, and it will all come out just like it is supposed to. But guess what? In the real world it rarely happens the way we predict with our models. The reason people want it to be that way is because prototyping is not cheap—it is not cheap in terms of money or the time required to do it. It is messy and sometimes you are embarrassed with the results, but eventually you reach your goal. In the long run, it saves you money.

The company who won was not afraid to learn from its mistakes, and prototyping was an essential part of their strategy.

THIRTY-SIX

For Better or Worse"

LARRY LAWSON

VICE PRESIDENT

LOCKHEED MARTIN CORPORATION

Soon after we won the contract to be the sole source provider on JASSM, Terry and I realized that the majority of his people needed to become helpers—not just the handful who worked with us during the rolling downselect. Their job up to this point had been to measure us and to critique us so that they could do a source selection. For the program to continue moving ahead, his people could not be in the critique mode any longer. We had to all play as a team.

At our first offsite after-contract award, Terry got up to speak and said, "Let me be clear, we're married now. We must work together—so don't come to me with a bunch of domestic squabbles. Divorce would be devastating"

I was there with the Lockheed Martin team and had already given them a similar message: you now have to interact with the government team differently. We are not in source selection. We are all teammates now, responsible for the success of the program, and you must be completely open. The first thing I did

was bring several of the government folks into our facility, I invited them to all of our meetings, and I also made Terry's deputy my number-two person. He moved his office into our facility and sat across the hall from me.

Whenever Terry or I felt like his people were reverting to their traditional role of overseeing the contractor, we met with the key individuals involved to talk about it and invariably this led to an offsite with the whole team. Our offsites were crucial in maintaining the focus and reinforcing the message that we were all working together.

And they were invaluable in other ways. People got to know one another and realized that they weren't slimy contractors or inconsiderate government employees. These were people with real commitments to what they working toward, at work or home. You discovered their motivations. Were they all motivated to make this program successful? Almost universally, the answer was yes. The offsites helped to build and maintain a strong teaming relationship throughout the program.

"I definitely felt like we made the right decision. I knew that if Boeing protested, they would not win. They knew they couldn't win, once they saw the affordability numbers. It was cut and dry. I know the helping team that was with Boeing was enormously disappointed when Boeing lost. It's strange, but I had a huge sense of loss, too. I was wishing that we could still keep working with them, that we could produce two missiles, but we couldn't afford that. That was the sense I had at the end of the downselect."

— Jackie Leitzel

THIRTY-SEVEN

Switching Uniforms

BRIAN RUTLEDGE

FINANCIAL MANAGER/PROGRAM MANAGER

U.S. AIR FORCE

Terry asked Larry Lawson after Lockheed Martin won the downselect, "Do you want to keep Brian Rutledge in the program?" Then he went through the rest of the people on the Boeing helper team. Larry knew the Boeing helpers were a good bunch. For instance, one of our guys had worked in testing, and Larry's team was behind when it came to testing. He knew that this guy would be an asset to Lockheed Martin.

Ultimately, every one of the Boeing helpers ended up working for Larry, and he fought to keep us. Larry told me later, "I wasn't stupid when Terry asked me if I wanted you to stay on JASSM. He wanted to get rid of you and the other helpers, but I said no way." Larry also told me that Terry had said, "You keep an eye on them, and if they aren't team players we'll get rid of them."

Terry believes it is in the best interest of the program to get rid of all the government helpers who worked with the losing contractor. When he came to JASSM, he said that everybody who went to work for the losing team during the downselect was going to leave the program after the contract award. He didn't believe we could transfer our loyalty from the losing contractor to the winner.

Now I don't agree with that. When a person takes off his Yankees uniform and goes to the Red Sox, he brings all of his technical capabilities, his knowledge, and his drive to succeed. I don't know why you should expect less of people who are driven to succeed on other kinds of teams.

THIRTY-EIGHT

Something I've Noticed

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

You can tell how important a project or program is to a company by the quality of the person who is put in charge. If they've got a quality person running the project, that means that it's important to them, and more than likely they are going to do well. If they've got a sad sack running it, then it's more than likely that this isn't an important project in their overall scheme of things, and chances are they are not going to do very well.

I have seen companies replace a good program manager with someone who was awful, and it didn't take long for that to show. By saying "awful" I don't mean technically incompetent. I mean someone who is incapable of trusting and being open, with too much of an engineering mentality, who is always in kind of in a defensive mode: It's got to be by the numbers, What does the contract say? That's how they want to do business, and in a couple of instances where that happened, as I recall, it wasn't long before the program began to show the bad effects.

THIRTY-NINE

What's in the News

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

I suggest that all project and program managers consider publishing a newsletter for their team members, including their contractors. Your newsletter should extend beyond the boundaries of the program. By sharing this information with the entire team, you break down silence and give everyone a stronger sense that "we are all working together." Yes, you make yourself vulnerable by being open

and putting your thoughts in writing, but you build trust when you make yourself vulnerable to others. People ask me why I am so open about the failures and successes of my programs, and I tell them, “Because leaders lead by example.”

FORTY

First Shot

LARRY LAWSON

VICE PRESIDENT

LOCKHEED MARTIN CORPORATION

After months of seven-day weeks, our first missile launch after the contract award failed. Our first launch!

This worried me because up until that point some of our innovative designs were unproven other than through extensive subsystem testing such as in wind tunnels, hardware in the loop, and detailed modeling. Everything before flight testing is substantiating data and simulation. The competitive phase didn't allow either team to fly.

A tremendous effort had gone into that first shot, and the team was shaken. I met with the team, “This is not the time to lose confidence or allow fear to keep us from solving this problem. We have to be of sound mind and spirit. This will require our best thinking and effort. We have to be determined that we will get this fixed.” At that moment, we all questioned ourselves, Are we up to it or not? We turned the flight failure into a challenge to correct the problem and fly again by the previously planned next shot date. We would not break the schedule.

It was the defining moment for the program. The status quo response would have been, “We need six months to figure this out.” Terry could have said, “I don't trust you, and I want to have an independent technical review. Oh, by the way, I want a report every day.” But that's not what he said. Terry did the right thing. He did not roll in on us. He did not send his people in to stand over our shoulders and say, “You really messed up here. We don't trust you.”

He asked me if I wanted some help. I said, “I'd like to have these three or four people from your test organization come down.” These were people who had expertise in specific areas. He sent them down, and they went to work.

Teams are defined by how they react in adversity—and how their leaders react. Terry's reaction, I think, was absolutely right. He decided, “I'm going to let you solve this problem.” His decision demonstrated trust, and it set the tenor for how we moved forward as a program.

It turned out that there was nothing inherently wrong with the system. The problem was associated with some test-related analog circuitry requested by the safety team. The circuitry inhibited the system from attempting to operate under extraordinarily unlikely conditions. The process of corrective action determined that the tested condition was not a safety threat and the system response was inap-

propriate. The failure focused the team on challenging all requirements, and focused us more on testing every detail prior to flight. We redesigned the circuit, and six weeks later shot a missile and it flew beautifully. That was no doubt one of the most pleasing moments in my career. The lessons learned by this team about how to respond to adversity enabled us to solve bigger challenges and keep the remainder of the test program on track.

JASSM NEWSLETTER, 19 April 1999

On Being A Team

A few weeks ago I went home to Dallas to visit my Mom and Dad. Although I have not lived there in more than 30 years, Texas is for me, as it is for many native Texans, still home. As I drove from the airport to my parents' house in heavy traffic, my mind was as far away from work as it ever gets. While I was momentarily stalled on a freeway, I noticed that the car in front of me had a Dallas Cowboys sticker on the back window. As I began to move again, I idly began to count Dallas Cowboys stickers on other cars as they passed me or I passed them. By the time I got home, I had counted a grand total of four. This was somewhat amazing to me, because I could remember a time when virtually every car in Dallas had such a sticker. I began to reflect on the reasons for this change and concluded that during the Cowboys' "glory days" ("America's Team," Super Bowl champs, etc.), everyone on the sidelines wanted to identify with a winner, but when the winning stops so does the identification with the team. Human nature, I guess.

What about the people on the team? It's the same human nature at work, but the results must be different. When there's a loss or a series of losses, it's natural for team members to want to assign blame, disclaim ownership, and criticize or redefine the intra-team relationships. The team becomes dysfunctional. Being a part of a team demands that everyone on the team own every outcome in equal measure. Irrespective of whether the outcome is good or bad, everyone must share responsibility for it, or else leave the team. When the outcome is not what we would have liked, it's tough. But that's precisely the time when functioning as a team is most important. It does no good to belabor adversity or look in the rearview mirror. All we can affect is what's in front of us, not behind. What we accomplish in this program, I am convinced, hinges not on individual team members, but on how well we function as a team. We cannot let our togetherness depend upon whether someone else has a window sticker.

Source: "Open Newsletters," *ASK: Academy Sharing Knowledge, the NASA Source for Project Management*, January 2002, p. 36.

During a flight test held at White Sands Missile Range, New Mexico, Major Wayne Opella, an F-16 pilot with Eglin's 46th Test Wing, launched the JASSM at about 15,000 feet up, while cruising at roughly 500 mph. The weapon separated cleanly from the aircraft, deployed its wings and tail section, and ignited its engine at the proper altitude to begin a 70-mile dash toward the target array on the desert floor. According to Dale Bridges, Eglin's JASSM Systems Program Office technical director, the cruise missile's GPS navigation system functioned flawlessly during the flight, recognizing three navigation way points and completing the necessary maneuvers to keep it on the pre-programmed mission attack plan. As the JASSM approached its target, it performed a pitch-over maneuver and dived on the target at a 70-degree impact angle. The state-of-the-art infrared imaging seeker recognized the target scene and guided the weapon to a hit.

Source: "JASSM Proves Deadly Accurate in First Development Test Flight," press release from Air Armament Center Public Affairs Office, Eglin Air Force Base, 31 January 2001. Accessed at <http://www.fas.org/man/dod-101/sys/smart/docs/man-sm-jassm-010131.htm> on 30 September 2004.

FORTY-ONE

A Terry Little Rule

TERRY LITTLE

PROGRAM DIRECTOR

U.S. AIR FORCE

We had a test where a warhead didn't go off. The flight of the cruise missile was perfect, but the warhead didn't go off. You could look at this and say, "Well that's just one little piece of it." But if the warhead doesn't go off, you don't have a weapon.

In this case, we quickly determined that there was a design problem with the fuse, and we moved on to have a successful retest—but not before we mined every bit of information that we possibly could out of that failure.

Whenever there is a failure, the first thing to do is to go through a short grieving period. On JASSM, whenever we had a failure, I allowed grieving for one day. We could grieve and mope, get drunk, wring our hands, say "ain't it awful." We could do that for one day, and then it was time to put it behind us. That's a Terry Little rule.

Then we look forward and start saying, Where are we going? What do we have to do? How do we get ourselves back on track? But first we must forgive ourselves for that failure or that problem. When you have a problem on a project,

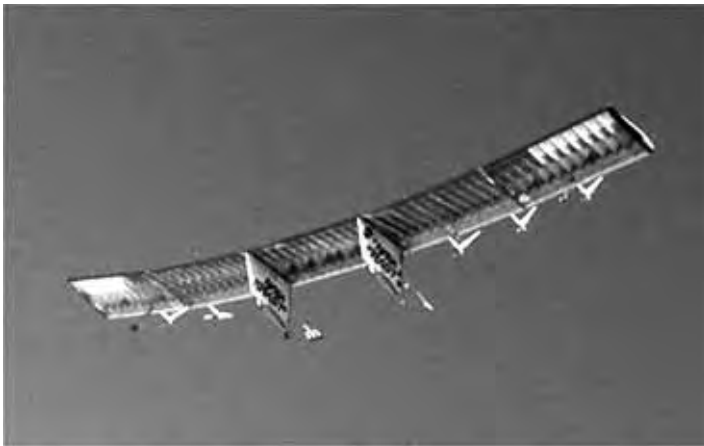
all of a sudden people want to know, What's going on? What's the problem? Most project managers want those questions to go away, so there is a tendency to want to jump to the solution and respond, "Don't worry, we've got this in hand. It was just one of those things."

What you need to do is dig until you get to the root cause of the problem, until you are certain that you understand why this failure happened. Yes, it takes a little longer. Yes, it costs more money. In my case, a week to get to the root cause of a problem is \$4 or \$5 million. But you've got to do it, so that when you move forward you know that you have learned from the failure. A lot of times what caused it will be a gnat, but you should still kill it with a sledgehammer and smash it to bits until you are convinced that, though you may have other failures in the future, that particular one will never occur again—ever. You can't move forward from a failure if you're worried about repeating the same mistake.

It would be nice if failures never happened, but any time you undertake something that has significant risk, no matter how well you attempt to do it, no matter what the caliber of the team, no matter how much money you have to spend, there will always be times when you have failures. Therefore, every successful test that you have should be a cause for celebration. It's a big deal, a very big deal. Even though in and of itself it may be just one small milestone, there is an enormous amount of energy and effort that goes into getting to this point, a point at which all of our individual work bears fruit and becomes something bigger and better than the sum of its parts. This is how we know we are a winning team.

Chapter 4

FLYING HIGH ON SPIRIT: THE PATHFINDER SOLAR-POWERED AIRPLANE



THE PATHFINDER SOLAR-POWERED AIRPLANE

In 1994, NASA initiated the Environmental Research Aircraft and Sensor Technology (ERAST) program. ERAST was to be focused on converting high-altitude, long-endurance unmanned aerial vehicles (UAVs) into research platforms. Because of the extraordinary difficulty in controlling the risks involved, UAV industry development lagged far behind the interest in and knowledge of how to improve the technology. Few commercial companies were making money in the UAV business; in fact, crashing planes were more the rule than the exception.

To mitigate the risks and attempt to stimulate the industry, NASA offered four of the main players in the industry an unprecedented opportunity. Formed under a Joint Sponsored Research Agreement (JSRA), ERAST required only nominal cost-sharing by the companies. In exchange, NASA offered not only the rights to commercialize, but also ownership of all the hardware developed. The UAV

companies were skeptical when first approached by NASA about becoming part of the ERAST Alliance; in past NASA contracts, it had not been easy to get even the commercial rights to the products they had developed.

With some trepidation, four companies embarked on the adventure with NASA. This case focuses on one of these companies, AeroVironment, and its solar-powered vehicle: Pathfinder. The dominant technological challenge facing AeroVironment and NASA was to operate an aircraft that was both light enough to fly and large enough to be powered by the sun and carry meaningful payloads. If this was to be done, it would be through careful attention to the design of the aircraft and its systems, and by doing business in an entirely new way.

SOURCES:

Jenny Baer-Riedhart, Program Manager, NASA Dryden Flight Research Center
Ray Morgan, Former Vice President, AeroVironment Design Development Center
John Del Frate, Deputy Program Manager, NASA Dryden Flight Research Center
Jeffrey Bauer, Chief Engineer, NASA Dryden Flight Research Center
Bob Whitehead, Associate Administrator for Aeronautics, NASA Headquarters
Dougal Maclise, Payload Project Manager, NASA Ames Research Center

ONE

“It’s a Bird, It’s a Plane, It’s . . .”

JENNY BAER-RIEDHART

PROGRAM MANAGER

NASA DRYDEN FLIGHT RESEARCH CENTER

“Where’s the rest of the plane?” That was my reaction when I saw the Pathfinder, AeroVironment’s solar-powered airplane, and one of four aircraft that were part of NASA’s Environmental Research and Sensor Technology (ERAST) program. I had just been named program manager, and was seeing the plane up close for the first time. I had to ask, “Will it fly?”

It was an odd looking bird. Actually, I’d seen pictures of it in the air. That didn’t mean I was no longer a skeptic, but I was glad about the pictures. They were a cool antacid to soothe my gut feeling about the plane.

Unmanned aerial vehicle (UAV) technology is inherently risky and not considered an especially sound investment. This was especially true in 1994, when we kicked off the ERAST program. The idea behind ERAST was to minimize the risks as much as possible by joining forces with the best companies in the industry. You’re probably wondering: What’s the fuss if one goes down? Nobody’s in the plane, right?

But the thing is, it’s bad press when public money is spent on programs that crash, literally. The cameras start rolling, and then the heads. NASA doesn’t like to explain away its failures on Capitol Hill.

ERAST was a new way of doing business for NASA. The Agency had been involved in similar partnerships before, but they were all university-led. This was the first industry-led alliance of its type. NASA provided some funding to the companies, but they also had to pony up their own resources. We had a “best effort” agreement. At any time, one of the companies could say, “We’re done, we’re walking.” All they had to do was return what money they hadn’t used.

Spelling Out the Alliance: E-R-A-S-T

The core ERAST Alliance partners are NASA and four aircraft developers who jointly set goals, leverage costs, and share technology R&D and demonstration projects. The Alliance functions under a unique legal arrangement, called the Joint Sponsored Research Agreement, which sustains a collaborative relationship between key partners, and permits the addition of new partners from the government, industry, or academia.

Source: ERAST Alliance Web site, accessed at www.eraст.com/ehtml/alliance.html on 30 September 2004.

If the alliance was successful, everyone would get what they wanted. NASA hoped to leverage these aircraft and their technologies to demonstrate the viability of UAVs for atmospheric science, and the companies would be able to apply their work towards commercialization. Part of the ERAST charter was to “kick-start” an American UAV industry. Each of the four companies brought a unique focus toward developing a UAV, and each had at least partially-developed UAVs that were potentially suitable for NASA’s stratospheric science missions.

And me? How did I come into the picture? I had just finished up another program to develop a next-generation UAV. We built the plane at low cost, and put it in the air to see what would happen. It crashed. Still, nobody was ready to give up on this technology. The knowledge was there to build UAVs—it was the cost and operational factors that made them unpopular.

TWO

A Little Bit of Dog Training May Be Required

RAY MORGAN

FORMER VICE PRESIDENT

AEROVIRONMENT DESIGN DEVELOPMENT CENTER

(CURRENT PROPRIETOR OF MORGAN AIRCRAFT & CONSULTING)

At the end of 1994, NASA was in the process of forming the Environmental Research Aircraft and Sensor Technology (ERAST) program. We at AeroVironment believed that a solar plane was uniquely suited to the extreme duration and altitude goals of the ERAST program. Not everyone else who was involved saw it this way. Winning them over to our opinion, and to the Pathfinder, was going to require us to perform well, if not better than everyone else.

Initially, the other companies considered Pathfinder to be too impractical, and they almost voted AeroVironment out of the alliance. What persuaded them to let us stay was our experience. Compared to the other three companies, we were old timers in the UAV industry. The Pathfinder was by no means AeroVironment’s first foray into solar-powered aircraft. Unlike the other companies, we had been developing UAVs for over 13 years, and had seen all the ways to crash them. In the end, the other companies recognized that learning from others was perhaps the only way to avoid repeating their mistakes.

One problem that many small UAV companies shared at that time was the “silo” syndrome, which simply meant that they attacked each task as if they were the first ones who had tried to solve a particular problem. As a consequence, the industry as a whole was plagued by stupid mistakes and the duplication of problems that had been encountered and solved 50–60 years earlier. NASA intended to help open doors by creating “cross-pollination” between the companies and the Agency, so that we wouldn’t keep making the same mistakes.

Pathfinder Specs

- Wingspan: 98.4 ft
- Length: 12 ft
- Wing chord: 8 ft
- Wing Aspect Ratio: 12 to 1
- Gross weight: about 560 lbs
- Payload: up to 100 lbs
- Airspeed: approximately 17–20 mph cruise
- Power: arrays of solar cells, maximum output: about 7,500 watts
- Motors: six electric motors
- Endurance: about 14–15 hours, daylight limited, with 2–5 hours on backup batteries.
- Glide ratio (power off): 18 to 1
- Primary materials: carbon fiber, Nomex, Kevlar, plastic sheeting, and plastic foam.
- Manufacturer: AeroVironment, Inc., Monrovia, California

Source: National Aeronautics and Space Administration, “Pathfinder: Leading the Way in Solar Flight,” *NASA Facts*, (Edwards, CA: Dryden Flight Research Center, FS-2002-034 DFRC, 16 June 1993), p. 3.

Although most of us knew the others from prior experience, working together in this way would be an entirely new way of thinking about our relationship to one another. For one thing, we were all rivals in a fairly ruthless and highly competitive industry. The “big four,” as we came to think of ourselves, had lost out to each other on prior programs. I tended to see us as four hungry dogs looking at the same piece of meat. That may sound a bit harsh, but it was that kind of industry.

It wasn’t just the four of us that made the industry crowded with competitors. On one side, we had aerospace giants willing to lose money on a contract in order to gain a toehold in this fledgling industry, even by losing more than the contract was worth. On the other side, we had “garage” operators who underbid by factors of four or five, because they had no clue about the complexity of the task they were bidding on. They might win a contract, but they went out of business after they failed to deliver.

Like most new relationships, the alliance went through an initial courtship phase, followed by a few spats, before it settled into an ongoing relationship that worked, more or less, for the good of all. I think it was best said (I’ve forgotten by whom), “If I have a dollar and you have a dollar; and I give you mine and you give me yours; we each still have a dollar. But if I have an idea and you have an idea; and I give you mine and you give me yours; then we both have two ideas.”

THREE

Doing Business

JENNY BAER-RIEDHART

PROGRAM MANAGER

NASA DRYDEN FLIGHT RESEARCH CENTER

Under the Joint Sponsored Research Alliance (JSRA), NASA and the companies put funding into a shared bank account. By joint agreement, American Technologies (AmTech) then distributed funds to all of the partners. The companies submitted costs and schedules to AmTech, who forwarded them to me for approval. AmTech served as the go-between for the companies and NASA throughout the life of the program.

NASA and the companies agreed on business plans at the annual alliance meeting. Each year at this meeting, I laid out the requirements for the program, based on input from all of the parties. Together, we evaluated our working business plan against these requirements. We set programmatic milestones, as well as milestones for each of the companies.

NASA's vision at the start of the alliance was for the companies to get together to build one airplane. They preferred to get their own money, build their own planes, and have a fly-off. I urged them not to go that way, but there was only so much influence that I could exert because under this JSRA we weren't working from a standard contractual agreement.

FOUR

Check Your Ego at the Door

RAY MORGAN

FORMER VICE PRESIDENT

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Because ERAST was a different way of doing business, we had to tailor almost everything about the program, and that included how we did reviews. In a typical NASA contract, you wouldn't rely on the contractor saying, "We're good to go," while NASA nods its head and says okay—but that's what we did. The companies could take NASA's advice, or they could ignore it altogether.

The other alliance members had less experience than we did in developing UAVs, and they probably didn't have as much appreciation for processes and learning from the past. We understood that while NASA might not have known much about our particular UAV technology, the Agency did have a lot to teach us about basic airplane technology and how to safely test one-of-a-kind, developmental aircraft.

For the ERAST reviews, NASA would bring in people with experience in a particular area of aircraft development and testing, even though they often had no prior background with UAVs specifically. The point was that NASA had within its ranks a wealth of experience and judgment in developing and testing unique air vehicles, particularly at high altitudes. (Some members of the review team had taken the X-15 to over 300,000 feet in the 1960s; we were aiming at a fraction of that altitude.) Even though they were not familiar with these particular types of light wing structures, these were still experts in physics and engineering, and the atmosphere we were operating in was the same. Many times they provided the most value by simply asking questions.

NASA provided AeroVironment with valuable advice about how best to implement redundant systems in its critical components, particularly when the system must automatically determine which sensors are working properly and which are not. In the first prototype of Pathfinder, built in the early 1980s, we had relied on single thread systems across every major component of the UAV. This meant that there was only one of any given component, and if that one component failed, then the whole UAV would likely fail. NASA's input was critical as AeroVironment began focusing on system optimization.

NASA also brought to the table its vast experience in risk management. This was something AeroVironment had never formally approached, but it was old hat to the folks at NASA Dryden who were on the review team. Assigning a quantitative measure to subjective judgment of risk is a difficult concept, but it is critical in conducting flight tests safely. Heretofore, it was joked that UAV manufacturers put "more holes in the desert than Arnold Palmer." However, for these large, expensive, one-of-a-kind UAVs with NASA logos and public scrutiny, crashing could not be taken lightly.

FIVE

Check It Out

JENNY BAER-RIEDHART

PROGRAM MANAGER

NASA DRYDEN FLIGHT RESEARCH CENTER

The companies who were not as open about accepting NASA's advice fared worse in this alliance. One of these companies we will call X. On paper X was a superb company. Man for man, employee for employee, every one of them was a genius in his own right. Still, despite their superior IQs, they crashed their UAV—twice, actually.

The unfortunate thing is that their crashes might well have been avoided had they been willing to listen to what NASA had told them. When X crashed its UAV, the precipitating cause was the failure of a single thread component. NASA

had spotted this and warned them of the catastrophic consequences of not switching to a redundant system. X ignored the advice.

When the component failed during a flight test, the UAV flew out of control. With no backup means of recovery short of an act of God, the UAV was doomed to crash, and so it did. Twice, as I said.

Had X been open to what NASA's experts pointed out during the reviews, they might well have kept from crashing. Generally, their attitude towards NASA was negative. They choose not to discuss their problems, share information, or see reviews as something that they might learn from.

Another company in the alliance, call them Y, also crashed their UAV. They, too, rejected NASA's advice about developing a redundant system for a critical component. In this case, the UAV had two data links. To conduct one particular operation during flight, they had to switch from the primary data link to the secondary data link. Each time that the data were switched between the links, the data coming down disappeared for about six seconds.

When a critical component failed during one test flight, the pilot on the ground noticed that the sensor was not updating properly, concluded that no data was coming down, and switched from the regular link to the backup. After six seconds the data was still screwy, but by then the aircraft had rolled upside down. Here again, NASA had pointed out that using a redundant system would safeguard against a catastrophic turn of events should the critical component in question fail. The pilot finally realized that the lost data was not merely the result of the switch between the regular data link and the backup, but by then it was too late—the UAV was pointed straight down and could not be recovered.

SIX

Negative Training

JOHN DEL FRATE

DEPUTY PROJECT MANAGER

NASA DRYDEN FLIGHT RESEARCH CENTER

Flying these airplanes was risky, and the pilots needed “stick time,” as we called it. The companies used simulators to practice their operations and procedures. It should be self-evident, but remarkably often it is not: if you are going to use a simulator, it needs to mimic the actual flight hardware as accurately as possible.

In one instance, a pilot was practicing using an instrument to gauge the behavior of his plane on descent. The instrument, a rate meter, told him how many feet per minute he was descending. It turned out that his ground control station, in essence the cockpit, didn't work the same way as the simulator. In the cockpit, the rate meter didn't measure descent greater than 2000 feet per minute. We had a problem on a flight and had to shut off the engine and glide down into a dry lake bed. The pilot ended up coming down too fast. When he finally realized this,

Minding the Cockpit

The physical cues, such as sights, sounds, and odors, as well as the feel in the “seat of the pants” of sudden accelerations or vibrations, are naturally not part of the UAV pilot’s environment. To mitigate this deficiency, the test teams have had to use a certain amount of ingenuity. In the case of the Pathfinder, two things stand out to the casual onlooker. First, the stick is very nearly the same as those used in remotely controlled model airplanes. Second, the downlinked video is not a view out the front of the UAV but rather is a view from a camera positioned on the left wingtip looking inboard at the airframe. It is used primarily for monitoring the vehicle structure, motors, and propellers as opposed to looking at where the UAV is going.

Source: John H. Del Frate and Gary Cosentino, *Recent Flight Test Experience with Uninhabited Aerial Vehicles at the NASA Dryden Flight Research Center*, NASA/TM-1998-206546, (Edwards, CA: Dryden Flight Research Center), April 1998, p. 6.

it was too late—he broke the landing gear. There were other ways in which he could have known that the plane was exceeding safe speed and was in danger of crashing, but he wasn’t paying attention to them. He trusted the rate meter because of the simulator’s “negative training.” This flawed training cost the company nearly a year of repair work.

SEVEN

Refining Flight Procedures

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AEROVIRONMENT DESIGN DEVELOPMENT CENTER

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With UAVs, what the pilot does is just a tiny fraction of what the airplane is trying to do. To fix a problem, you usually need to get a grasp of an entire system. When developing small, quick-and-dirty prototypes, it is often economical to just “fly it” and see what kind of problems there are, but sloppiness is intolerable when you work with expensive and essentially irreplaceable airplanes like the Pathfinder.

For the longest time, we weren’t procedures-oriented at AeroVironment. One guy at the top typically wrote our flight procedures, and often he would leave out a lot because— after all—he’s just one guy, and there were things he didn’t think about.

Hence, we realized a couple of common sense things to help refine our methods of writing flight procedures: 1) one person is not as smart as a group, and 2) a person at the top may not understand things the same way as someone looking at it from a different perspective, such as a technician who is actually performing the task. If you bring together all the people who understand parts of the system, you will develop better procedures by using each of their areas of expertise.

Another problem that stemmed from having one guy write the procedure was that different nomenclatures were being used. If the person writing a procedure had gotten used to calling something by a nickname, that's how he would identify it in the procedure. But if other people who had to use the procedure weren't familiar with that nickname, you can imagine their frustration in trying to understand what the author of the procedure was talking about, not to mention the potential for disaster that existed because of this.

But the most significant problem we found with autocratically handing down procedures was that people were far less likely to follow procedures that they neither created nor could change. Procedures are tools. Like tools, they need to be sharpened and honed, and all good craftsmen like to sharpen their own tools. What's more, people feel less stress when they can control how they perform their tasks. Our first rule was always to "put the person closest to the problem closest to the solution."

Whenever possible, the person(s) who actually performs the task creates the procedure for it. Providing this type of ownership is invaluable. It is also the most efficient way to create the procedure. Certainly, we had people cross-checking their procedures with co-workers, but even so we recognized that we had to provide a way to handle inevitable mistakes. This process of continuous improvement by the "owner" of the procedure accelerated the rate of development of the procedure; it allowed us both to rapidly refine a procedure and to respond quickly to changes in the system during the flight test program.

An important caution might be added. It is essential that the person responsible for the procedure has available the information necessary to understand its impact on other systems. A good work breakdown structure and good communication are essential.

The AeroVironment Procedure for Refining Procedures

1. First, we read through the procedure with a group of people who were involved in writing it. We also invite other people who were not directly involved to provide some objectivity. We get a number of changes from that—and that’s generally where we catch inconsistencies in nomenclature. On the next iteration the labeling is usually very close to being error free.
2. Next, we get everyone together for another read through. This time we have the actual hardware in front of us, and we practice just as we would as if we were going through a flight—a prototype of sorts. This time we might catch, for example, that the pilot was told to turn the damping switch off before he started another test that required the damping switch to be on. The guy who owns that process—it may be the pilot, it may be a stability and control engineer—takes note of that and is responsible for correcting the current version of the procedure. We may also discover at this point that the name of a switch in the procedure is not the same as the name on the switch hardware . . . a big source of confusion.
3. The next time we sit at the ground control stations—at both the stationary one and the mobile one that follows the aircraft during takeoff and landing. We go through the whole process again with the same people, using the latest rewrite. This is the last run-through before the actual flight.
4. After the flight, we get a group together to look at whether there were any abnormalities that could be attributed to a procedure, and we discuss any “red-marked” changes to a procedure made during the flight. The person who “owns” the procedure captures any issues that come up and corrects the procedure before the next practice. Not every task may require such a rigorous approach for developing procedures as we used at AeroVironment for the Pathfinder, but certainly all tasks where safety is preeminent benefit from this sort of attention to detail.

Source: Ray Morgan.

EIGHT

Blown Away

JOHN DEL FRATE

DEPUTY PROGRAM MANAGER

NASA DRYDEN FLIGHT RESEARCH CENTER

One cannot say enough about developing and documenting a good set of procedures and practicing them. It is grueling work, it takes lots of time, and it requires an incredible amount of coordination with team members. You have to do it because this is the time when you discover discrepancies that can make the difference between saving a plane and crashing it; and it includes, after the practice session, going through all the red lines and analyzing them, rewriting them if necessary, and practicing them again and again until they run as predictably as clockwork. I saw a lot of cases where maintaining the project schedule started to become a problem, and some of the companies started to basically skimp on the amount of time that they spent practicing their procedures. Not AeroVironment, they were religious about how they developed procedures. When I showed their procedures to some of the guys at NASA Dryden who were in the flight-test business, they were blown away by how precise the details were.

NINE

Data Memos

JEFFREY BAUER

CHIEF ENGINEER

NASA DRYDEN FLIGHT RESEARCH CENTER

When I joined the ERAST Program in 1995, first as Chief Engineer and later as Deputy Project Manager, I had a lot to keep track of—four flight projects and numerous technology development initiatives. One company, AeroVironment, had developed a system for documenting their project activities that proved to be especially effective in communicating project status.

My background was in flight research, not solar power, and certainly not with such a unique vehicle as the Pathfinder. What allowed me to stay abreast of their progress was their system of using project data memos. Data memos were intended to communicate to everyone in the program what was going on with the Pathfinder project. Everyone in the alliance had access to the database. Great efforts were made to make it easy for anyone to generate a data memo. Aside from the title block, there was no format required. Even notes jotted on scraps of paper proved worthy of making it into the file.

A record keeper assigned a number to a memo and sent it out to the distribution list. People could decide for themselves if they wanted to keep it or not. The record keeper was also charged with logging the data memo by number and

subject onto a server. Thus, if someone on the project received a data memo, deleted it, and then decided at a later date that it was important, he could retrieve it from the record keeper.

Data memos are meant for those who are on the project team, and are intended to communicate to the entire team what is going on. I found them an excellent means of sharing information and providing everyone with access to the information in a timely manner, as well as serving as reference points later in the project. The data memos allowed me to ask intelligent questions, and they served to educate me about systems and technology that I was unfamiliar with. Overall, they set an important precedent for what we hoped would become common practice among all the members of the alliance—a practice that engenders openness, teamwork, and trust between team members.

Procedure

1. I am working on a document, e.g. Power Requirements for the flight termination system. These are the requirements, and the document becomes how I want the requirements to be met.
2. Once I have completed the document, I send it to the individual who maintains the database. This person (the record keeper) assigns a number to it and sends it out to the distribution list, which is essentially everyone involved in the project. People can decide for themselves if they want to keep it or not or archive it themselves.
3. The record keeper is also charged with logging the data memo by number and subject. Thus, if someone on the project received a data memo, deleted it, and then decides at a later date that it's important and wants it back he can get it off the server.
4. As the project evolves and as you gain more knowledge about particular subjects, you will often go back and add information to the original data memo. If you decide to add to or comment on a data memo, you send your new data memo back to the record keeper, who distributes it and logs it as a response to the original.
5. In general, if you needed access to a memo you didn't have, you could get the record keeper to look it up for you by providing information on the title, author, or date, etc. Often the best way to obtain an old memo was to ask the author for a copy. If I knew that a memo was written regarding the solar panels, I would call the engineer responsible for the panels, and ask him for the memo. He would generally give me the memo number and I would get a copy from the record keeper.

Source: Jeffrey Bauer.

TEN

Know Thyself—But Don't Forget to Learn About Your Customer, Too

JENNY BAER-RIEDHART

PROJECT MANAGER

NASA DRYDEN FLIGHT RESEARCH CENTER

I made several appearances at NASA Headquarters to brief higher-ups about the status of the ERAST program. Early on in this endeavor, I learned a key lesson in working with multiple customers: Always know the folks you're meeting with, and always tailor what you're going to say based on who you know will be there.

I learned this the hard way, I'm afraid to say, after getting thrown out of people's offices. At my first ERAST meetings, I wasn't as attuned to the personalities in the room as I should have been; I didn't know what their requirements were or what their problems might be with what I was saying. I failed to realize that I was perceived as a threat, a bearer of bad tidings.

"We've got this great UAV program back in California," I said by way of introduction at one of these meetings, and from that point on they hammered me. They didn't want to hear anything about a program aimed at developing UAVs. "This is not going to work! This is not the kind of airplane we want! Why are you telling us about this!"

From their standpoint, I was the enemy, someone who would suck up resources they needed in other areas. I should have understood this ahead of time. I had anticipated some resistance, but I naively thought that all I had to do was show up and explain how successful the program was and, voilà, they were in my pocket. Yes, I knew they were fighting for other platforms, and that they had their own constraints and clients to please, but I believed in my heart of hearts that ERAST was important for NASA and that I could convince them of that.

What I failed to recognize was that people are not convinced just because the seller believes that she has a wonderful product. The seller needs to understand what the buyer wants from a product.

At NASA Headquarters, the only way I was going to cultivate supporters was by putting myself in other people's shoes and learning what they wanted to get out of this program. I imagined that I was on the other side of the table, with a tight budget, and that I was looking at having to cut programs. "Tell me why we should keep you alive?" they were going to ask. What would I want to hear if I was in that position?

I would want to make sure I had a viable program, a program that I could get recognition for, one that I could get congressional backing for; it should be successful, and it might as well be unique, too. Even better, it shouldn't come with a big price tag. And that was how I packaged it.

But before I went anywhere near Headquarters again, I did some serious training. I got in shape. You might even say I went to boot camp.

I found people at Dryden who appeared regularly at NASA Headquarters to talk about their programs, and I used them as a sounding board. I found people from my Center and the ERAST alliance with areas of expertise similar to those I would address at Headquarters, and set up role-playing sessions, or what we endearingly referred to as “murder boards.” I briefed them with the charts that I was going to take, they told me what I’d be killed on, and I changed what I had to in order to stay alive. When I went back to Headquarters, it still didn’t feel like I was among friends, but at least I didn’t get kicked out of any offices.

The most compelling sales pitch you can make is not that you have something wonderful to sell. It is, “I understand what you need.” I gathered information from their own reports and figured out what mattered most to them. Then I said to them, “This is how I can deliver what you’re looking for: this airplane is going to provide you with sensors that are better than any of the ones you’re currently using. You’ll be able to use these sensors on the platforms you’re already flying, and at a much lower cost.” I brought charts that were worth more to ERAST than an original Picasso. Talk about visual aids, I had one with forty pictures showing all the things we were doing and how they related to existing programs. It was eye-watering. This time around, my Headquarters audience was blown away.

There are times when the role of the project leader is simply to sell the project. Projects can, and do, succeed because of politics. And they also fail because of politics. “Politics” doesn’t have to be a dirty word if it means working closely and openly with customers and stakeholders.

ELEVEN

Real Politic

BOB WHITEHEAD

ASSOCIATE ADMINISTRATOR FOR AERONAUTICS

NASA HEADQUARTERS

Everyone tries to get a piece of the Agency’s budget, but it’s not a fair fight. Aeronautics made up about 10 percent of the total NASA budget in 1995 when I was Associate Administrator at Headquarters. To put that in perspective, 60 percent of the budget went to the Human Space Flight division.

When President Clinton came into office, he made it clear what his priorities were: “It’s the economy, stupid.” That’s how he got elected—so we weren’t surprised when his Administration came knocking on NASA’s door to ask, “What are you guys at NASA doing about the economy?” Well, guess what? Space Science wasn’t doing anything about the economy. Human Space Flight, once you got beyond Teflon and Tang, wasn’t doing anything about the economy. But then there was Aeronautics—and it was all about the economy. Finally, we had more of a fighting chance.

On Sept. 11, 1995, Pathfinder reached an altitude of 50,500 feet, setting a new altitude record for solar-powered aircraft. The National Aeronautic Association presented the NASA-industry team with an award for one of the "10 Most Memorable Record Flights" of 1995.

Source: National Aeronautics and Space Administration, "Pathfinder: Leading the Way in Solar Flight," *NASA Facts*, (Edwards, CA: Dryden Flight Research Center, FS-2002-034 DFRC, 16 June 1993) p. 2.

In Aeronautics, our focus became potential economic impact, and that was to be found in subsonic transports and technologies that supported Boeing, Honeywell, McDonald Douglas and the other 800-pound gorillas. When you're in this kind of political pressure cooker trying to sell programs, other things can be viewed as distractions. I wasn't the person telling Jenny Baer-Riedhart to take her solar-powered airplane and go back home to Dryden. She came in at the level of people who work for me. Those people knew our strategy, and it was easy for them to say, "Whitehead doesn't want this."

But Jenny and her colleagues at Dryden came back to NASA Headquarters and stuck their noses in and pushed what they had to offer—and they deserve a tremendous amount of credit for that. They showed up at Headquarters, got turned away the first time, came back with a new message, got pushed aside again, but wouldn't go away—until finally we said, "Okay, if we fit this ERAST thing into the budget, then you'd better take it and run with it." And that's exactly what they did.

TWELVE

All for One, One for All

RAY MORGAN

FORMER VICE PRESIDENT

AEROVIRONMENT DESIGN DEVELOPMENT CENTER

(CURRENT PROPRIETOR OF MORGAN AIRCRAFT & CONSULTING)

NASA, being a sophisticated customer, understood the risks involved in developing and testing new technologies. They understood the vagaries of it all and how hard it is up front to predict what's going to happen. NASA also recognized that there are unknowns which cannot be identified during a program, and you have to be flexible with your budget to compensate for them. When you're doing things you haven't done before, it's hard to predict what it will cost.

A sophisticated customer makes a big difference, especially in a program like ERAST. NASA was our major customer, and we (AeroVironment) knew that

every time we flew we had our resumes in our pockets. We had other customers, but we knew that if we failed with NASA, and got thrown out of the alliance, we could lose a large part of our workforce.

In 1995, the first full year of the program, we ran out of money. We had on the order of \$3 million, but we simply hadn't gotten through the low-altitude tests before we had spent all of it. Our goal was to fly into the stratosphere, and we had not yet flown above a thousand feet.

With NASA's help, specifically Jenny's, we were able to borrow money from the other members of the alliance who hadn't spent all of their funds. Thanks to this, we were able to reach our performance goal for the year. In September 1995, Pathfinder soared to 50,000 feet during a 12-hour flight. This was a triumph for everyone in the alliance, because as a program we were able to point to an impressive performance metric as a reason to continue funding the program. We billed it as an ERAST accomplishment instead of AeroVironment's, and that was an overt decision. "All for one, and one for all." It paid off in that we all got more money.

In some ways, it was another important measure. When we (AeroVironment) were approached by NASA about becoming part of this alliance, it seemed difficult to believe that even if we shared with the other companies, our rivals, they would share equally with us—whether that was shared data, hardware, money, or you name it. Initially, we felt that we were the only ones living up to the letter of the agreement, but over time we started seeing others get the spirit. That's why, when I think about the 50,000 feet we reached in September 1995, I also view it in terms of the stratospheric leap we'd made as an alliance.

THIRTEEN

Close Calls

JENNY BAER-RIEDHART

PROJECT MANAGER

NASA DRYDEN FLIGHT RESEARCH CENTER

The first solar-powered, high-altitude flight at Edwards, California, where we reached 50,000 feet and broke a world record, provided a lot of excitement. This is the story that didn't get told when we were trumpeting our success.

Meteorologists had predicted calm winds after sunset. By 8 p.m., nearly 12 hours after takeoff, the forecast changed. The planned landing approach became a protracted battle with the wind. In fact, the plane flew backward during part of the approach because the wind exceeded the forward flight speed of the plane. Finally, as Pathfinder descended into the slower air below 50 feet, it began to move forward again, making a gentle touchdown at 8:20 p.m. on Rogers Dry Lake.

Despite the last 20 minutes of nail-biting action, we realized that the flight demonstrated the possibility of flying into the stratosphere and returning safely. The question then was, How high could it go?

FOURTEEN

Hangar Bash

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When we set the world altitude record for solar aircraft in September 1995, we knew the risks involved and took every precaution possible. But when the airplane was in a hangar on the ground, we assumed that it was inherently safe and that we didn't need to worry about procedures for its safety. We were shocked out of this assumption fairly dramatically.

In October, we were asked to display the Pathfinder at the Edwards Air Show, where it would be parked in a hangar near two classified aircraft, the B-2 and an F-117. Because these two aircraft were still classified and under armed guard, they were brought in at night after all the other aircraft had been placed in the hangar, and were removed in the same fashion.

The day that we brought the Pathfinder to the hanger, our crew chief told the attendant in charge that our plane was much more fragile than the others and that the attendant needed to be particularly careful when moving it or moving the other planes around it. He emphasized the Pathfinder's susceptibility to wind, because it was so large and light (it had a 100-foot span, but weighed less than 500 pounds). The hangar attendant seemed responsible, and we had no reason to doubt that he would do anything less than what we had asked. All went well, until the show ended.

During the night, an Air Force crew moved the B-2 and the F-117 to a different hangar. The guy we had talked to about our plane wasn't on duty, and hadn't talked to the people moving the planes. They opened the hangar doors on three sides to give themselves more room to work in. As they were working, a windstorm blew through the base, exceeding 30 knots (so strong it blew over all the portable toilets). With the three doors open, the hangar became a giant wind tunnel, and the Pathfinder was blown across the hangar and wrapped around the F-117 next to it. In the collision the spars of two mid-panels on the Pathfinder were broken, and much of the solar array on these panels destroyed.

The next morning when I learned about the accident, it crossed my mind that we might be finished. We didn't know whether NASA would give us the funding we needed to rebuild. The Agency sent a management team to conduct an investigation into the incident. When the report came in, it was just as we had already determined. No one was to blame for this accident but us. These guys who left the hangar doors opened didn't know how fragile Pathfinder was.

Because we already had some success on our test flights, and had demonstrated our ability to learn from our mistakes, we were able to secure funding from NASA

to rebuild the airplane. In so doing, we got to experiment with an improved structural design, building a plane that was more rugged, durable, and stronger.

An unexpected benefit of the accident was that we learned a tremendous amount about our plane. It demonstrated the extraordinary risk of span-loaded aircraft, and showed us that the loads they are exposed to on the ground typically exceed those seen in flight. What was even more important was that we recognized that we needed procedures to protect the Pathfinder on the ground as much as in the air. Had we not been as successful a team as we were at that point by focusing on continuous learning and improvement of procedures, we would not have recovered.

For many projects, an accident like this could have been catastrophic. For us it laid the foundation for pushing even higher into the stratosphere. We built a better plane, and we did so because we had a team that refused to be broken by adversity, and more importantly we had a knowledgeable and rational customer that understood the risks for flight-testing unique aircraft. We remained focused on learning from our mistakes. In fact it probably made us stronger because it proved that we could count on each other in the worst of times as well as the best.

Piloting Pathfinder

Pathfinder uses two crews. One crew performs the takeoff perched on the top of a van situated near the aircraft on the runway. This procedure allows the pilot to see the UAV, its orientation, and proximity to the ground. The pilot can also note any problems the vehicle may be experiencing and observe any potential traffic conflict. When the Pathfinder is approaching the visual limits of the first pilot, control is transferred to the second pilot and crew located inside the Ground Control Station. Upon return to the airport, the control of the Pathfinder is returned to the first crew for approach and landing.

Source: John H. Del Frate and Gary B. Cosentino, *Recent Flight Test Experience with Uninhabited Aerial Vehicles at the NASA Dryden Flight Research Center* (Washington, DC: National Aeronautics and Space Administration, 1998) p. 7.

FIFTEEN

Is it Spicy?

BOB WHITEHEAD

ASSOCIATE ADMINISTRATOR FOR AERONAUTICS

NASA HEADQUARTERS

When someone suggested that the projects we were proposing weren't anything to get excited about, I had to ask, "Is there any more spice out there? What about some innovation?" Then one of my guys said, "These whackos at Dryden came here talking about 100,000-foot airplanes and solar power." Well, why don't we look at that? It doesn't cost much. Can we broaden the appeal? Earth Science is struggling to get data in the 60,000 to 100,000-foot range. They'd rather get our money to build another satellite, but if we can give them some data in return for a little of their funding, they won't raise a flap.

When you live in the world that I lived in at NASA Headquarters, selling programs to the Administrator, Congress, and the White House, you are always looking to spice things up. One day the right answer is to sell them on economic impact, then the wind shifts and they want to know what cool, exciting things you're doing. Turbine engines are no longer the answer. It wasn't that I was some genius sitting at Headquarters who suddenly looked out, saw the light, and understood what the ERAST folks were doing. It was more like, "Hey, this fits the recipe."

SIXTEEN

Crash and Learn

RAY MORGAN

FORMER VICE PRESIDENT

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In 1980, I was hired to lead a project for AeroVironment, a small company run by a man named Paul McCready, who was known as the "Father of Human-Powered Flight." McCready was a visionary, a genius inventor, but he was not a project manager. That was going to be my job.

McCready had gotten Du Pont interested enough in his activities to sponsor a solar airplane that would fly from Paris to London. Solar power was still in its infancy, and nothing like this had ever been tried. In some ways it was a stunt, but if we could pull it off, it might be seen as a groundbreaking event in the development of solar aviation technology.

AeroVironment was an environmental consulting company, and all of McCready's projects with airplanes had been worked on outside the company. He wanted somebody to put together a team, do this project, and then disappear. I was working at Lockheed in Burbank, California, but I took leave of absence to join the

project. To me it was the dream of a lifetime, something I never thought I'd get a chance to do. Solar power was one of the last frontiers in aviation. It was pioneering in the truest sense of the word. I told McCready when we were negotiating my employment, "If I had another way to support my family, I would do this for free."

We would develop two planes. The first was a test bed called the Gossamer Penguin. It had been partially built as a scaled-down backup to the Gossamer Albatross, which flew across the English Channel as a human-powered plane. The Penguin had a solar panel that we planned to put above the wing and aim at the horizon so that we could fly and test it in the early morning sun. By learning as much as we could from those tests, we were going to design the airplane that we planned to call the Solar Challenger.

When I was hired by McCready in January, I didn't have a building to work in—let alone people on the project. To be on schedule, I had to demonstrate solar-powered flight on the Penguin by May, and we had a lot of ground to cover. I tried to do what I thought a good manager would do to get a project started—I found a building, had lights installed, and shelves built. But McCready wasn't happy. "Let's get going, and get something in the air," he told me.

The first time we went out to flight test the Penguin, I set up the same procedures we used at Lockheed. I was in the hangar at daybreak going through a checklist before we began the flight. McCready pulled the Penguin out of the building, telling me: "You can do that after the flight. Let's get it in the air before the sun comes up too high." He was right to be concerned about timing—as the sun rose higher, the turbulence would make the plane less stable, and then we wouldn't be able to control the fragile airplane. However, his dismissal of even the most minimal safety procedures would prove to cost us more time in the long run. We crashed the plane with varying severity over and over, often for the same reasons—broken parts not found and repaired, cables not properly connected, etc.

The most alarming aspect of putting the plane in the air without more rigorous reviews and precautions, however, was that—by McCready's edict—the test pilot was his 12-year-old son, Marshall. McCready reasoned that because his son only weighed 80 pounds, we could get away with fewer solar cells on the airplane.

Without a great deal of introspection, I relied on what McCready told me and what I learned from the few people left over from his earlier programs. I let them guide me, listening to what they said, and—often against my better judgment—going along with it.

One April morning, Marshall took off and began to fly our standard racetrack pattern. With the crew following on bicycles, Marshall climbed to about 25 feet above the concrete runway, and began a left turn. No sooner had the plane begun to bank when it suddenly began spinning around the left tip. The wing tip crumpled onto the ground with McCready's son inside the cockpit. As the wings folded up and collapsed, the boy fell out the side of the plane, and that was fortunate—because a carbon fiber spar from the left wing pierced the cockpit where his head had been only seconds earlier. It could have killed him. That was disaster number one.

Disaster number two was my reaction. I said never again, never, ever again would that happen while I was managing a project. I couldn't believe what I had done. I had almost killed a 12-year-old boy. Never mind that his father wanted him to be the pilot; I should have known better. I don't think I could have been any more traumatized had it been my own child in that airplane. And thus began an 8-year period for me where I became exactly the kind of boss that I said I would never be.

I stayed on at AeroVironment. We flew the Solar Challenger from Paris to Kent, England, and Du Pont loved it. McCready asked me to stay on and lead a new division of the company to develop solar applications. I couldn't pull myself away. The kinds of projects I was working on were intoxicating. We did about 25 projects over the next several years, incredible stuff, all types of flying things, including props for the movie industry. We built flying replicas of pterodactyls, solar-powered cars, underwater diver-propulsion vehicles. We did the electric prototype car for General Motors, the EV-1. This was the sort of job that, 10 years earlier, I never would have believed I could have.

From the outside, it looked like the ultimate job. But on the inside, I was a mess. Some days I felt so much stress in the morning driving to work that I almost threw up. The tension was so palpable that I could feel it when I walked in. I thought I had to control everything. Nothing happened without my approval. I had people lined up outside my office waiting for decisions because I made them all. I wouldn't trust anybody to do anything. I was not only killing the morale of everyone I worked with, I was killing myself. I was working 80 to 100-hour weeks. I worked weekends. I never took vacations.

People came to work for me almost crying because they were so grateful to be there, and in two or three years they were burned out. I was probably as bad a manager as you could be, and it was out of sheer desperation that I finally started to figure out that I needed to quit—or find a better way.

About that time, my wife saw a PBS special about Edwards Deming and his revolutionary views, which can be described as bringing the Golden Rule and the Scientific Method to management. She said to me, "You've got to see this." I'd read through a lot of management books, but nothing really spoke to me as a complete philosophy until I encountered Deming. I saw the television special and bought a few of his books. I had a longtime employee, one of the few that I could call a friend, whom I talked to about this, and he said, "They offer classes on this at night school at UCLA." I said, "Are you kidding? How can I go to night school? I don't have time to go to night school. I'm barely sleeping." And he said, "You don't have time not to go to night school."

I took one class at UCLA. By then it was 1989. At first, I thought this was the biggest waste of money. The guy that taught the class never told us anything. He just asked us questions; he seemed like the dumbest instructor I had ever had. But as time went on, I started thinking about the people in the class with me, people from all levels of their organizations, from worker bees to managers—this was the smartest group of people I had ever shared a class with. And then it dawned on

me: this was how the instructor worked. He was demonstrating the power of using the brains of the people around you through the way he was teaching. I asked myself, Why can't I get this out of my people?

Taking the first class at UCLA was just the beginning. I continued for two more semesters. Years of reflection followed, but the single biggest realization I had was seeing that most people want to do good work. Most of what I had done as a manager was kill the intrinsic motivation people already had to do good work. I had to start trusting and delegating and having confidence in their integrity. The essence of it was to learn from my people. I kept reminding myself that these are intelligent people who desperately want to do good work. My job was to let them do it.

This didn't immediately solve my problems, but it started me down the right road. I might have reverted back to my old self if I hadn't kept reminding myself of how miserable I had been—because it was very tough at first, in fact, it seemed like it was worse for a while. The fear of lost control was almost unbearable at first. By the time we joined the ERAST program and started developing the Pathfinder, I had wrestled with my worst demons and felt like I was not only a different man, but a better manager. What's more, I had finally begun to be a leader, and was leading my division in a transformation that enabled me to draw full value from all of the brains of my workforce.

SEVENTEEN

The One Thing You Need to Know

DOUGAL MACLISE

PAYLOAD PROJECT MANAGER

NASA AMES RESEARCH CENTER

Steve Wegener, who was in charge of sensor technology in the Environmental Research and Sensor Technology (ERAST) program, dropped by my office one day at Ames Research Center to tell me that he needed a manager for a sensor payload project. He asked if I was interested. Steve had a subset of projects under ERAST, and what he had in mind for me was to capture colored infrared images of the ground from a UAV to get “whatever” information we could from them. The “whatever” could be filled in later, he said.

There was going to be just one requirement, he added: display the UAV's high-resolution images on the Internet in real time. “One requirement?” I asked him. I was incredulous. I'd never had a project with only one requirement. Normally, they came in volumes.

Our payload, a digital camera and a computer, was flying aboard the Pathfinder solar-powered airplane. Take high-resolution images from the unmanned plane and put them on the Internet in real time. Okay, but what is “real time”? The term seemed a bit nebulous to everyone. NASA had only a few Web-operated

payloads at the time, and no one was certain what the benchmarks were. When I asked Steve, he said nothing more than, “Do the best you can.”

There are hundreds of reasons why project managers accept an assignment, and we all have ones that are important to us. I took this project because it seemed liberating to me compared to what I was used to. What I heard Steve saying was this: How you do it is up to you and your team.

I remember the reaction of the team at our first meeting. I put the requirement on a slide, projected it on a screen in the front of the room, and pointed to it. “Here it is—this is all we’re doing,” I said. Everyone’s stared at the single sentence on the screen. All fifteen of us in the room were silent. Then someone asked, just as I had, “One requirement?”

Like Steve, I pretended to be matter-of-fact about it, “Yeah.”

Too often, the people generating requirements feel obligated to work down to the design level. This doesn’t allow a team much flexibility to respond to any new information that becomes available as the project progresses. When projects are rife with uncertainty, especially technological uncertainty, formulating requirements too early—and in too much detail—can be a major mistake.

It sounds simple, just one requirement, but trying to pull it off was anything but that. We had countless problems to overcome, and each time we solved one, we always seemed to find more. The reality was that there was more than one requirement, many more, but these were the requirements that we gave ourselves. The point of having just one requirement was that it distilled the project down to what it was really all about, and this simplicity made it much easier to stay focused and trained on the goal.

Work With Joy

At the core of W. Edwards Deming’s philosophy is his 14-point management system. “The 14 points all have one aim,” wrote Deming, “to make it possible for people to work with joy.” For example, Point 8 exhorts managers to “Drive out fear and build trust so that everyone can work effectively.” How does one do that? Point 10 offers insight: “Eliminate slogans, exhortations, and targets asking for zero defects or new levels of productivity. Such exhortations only create adversarial relationships, as the bulk of the causes of low quality and low productivity belong to the system and thus lie beyond the power of the work force.”

Source: The W. Edwards Deming Institute, “Gone But Never Forgotten: Deming’s Teachings.” Accessed at http://deming.org/theman/articles_gbnf04.html on 26 October 2004.

EIGHTEEN

Going for the Easy Win

RAY MORGAN

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At the beginning of my management transformation at AeroVironment, starting with my embrace of Edwards Deming's philosophies in the early 1990s, I thought that I was going to tear down a dam and let a river of creativity and productivity flow through the valley. Well, I tore down the concrete dam, and I saw a wall of mud and sticks and ice with a few trickles of flow here and there.

People don't respond to big changes overnight. If they have lived under a certain set of rules, that's their expectation. Once I realized this, I decided to go for an easy win. I picked one thing to work on: meetings. Occasionally, something exciting went on at one of our meetings, where it was dynamic, where we played off each other and accomplished things; but, generally, that's not how it was. Meetings were a big waste of time. People dreaded coming to them.

So, I decided to change the way we conducted meetings. I organized a group of 6 people—by then my staff was about 30 people altogether—and we worked as a team to create a new model of how we would conduct meetings. We worked on it for six months before we had something we could roll out to the group, and then we continued to refine the process after that.

Instead of people dreading meetings, people enjoyed them. Meetings now had a purpose. People knew they were expected to participate. They came prepared. The biggest thing out of that was that there came to be this mutual respect for each other's time, and that rippled through the organization in many, many ways.

What happened to me as a result of this was that I learned to work as an equal again. I didn't dictate how things would be. I listened more, and judged less. I no longer tried to earn respect by trying to show that I was smarter or more experienced or better informed than the people who worked for me. So while meetings proved to be an easy win, it was by no means a small one, not for me at least.

Conducting Meaningful Meetings: Preparation, Focus, Closure

Preparation: Everyone attending should understand the purpose of the meeting, whether we're there to get information or we're there to make a decision. Thus, I believe in always having a clearly defined agenda.

The leader sets the agenda and sends it to the people he or she wants to attend. The leader calls the meeting and defines the aim of the meeting. Generally, I like to circulate the agenda the day before the meeting takes place. If you send it out too early everyone forgets why he or she was called there. In general, people don't do much preparation until the day before anyway.

The other thing the leader has to do is determine who should attend, and everybody there should be expected to talk. If a person does not need to talk at this meeting, then that person does not need to be invited. Let him do something more constructive.

Focus: Maintaining focus is the most important aspect of a good meeting, so while you are in the meeting make sure to remind the group of the aim of the meeting. Do this frequently, and realize that digressions are contagious. All it takes is for one person to feel like the aim of the meeting has digressed and, before long, points of view start flying around like arrows looking for a target. If other subjects come up, suggest that the protagonist schedule a meeting to consider them, but don't let them creep into this meeting.

Draw out views from all participants, not just the extroverts. Don't lose a viable point of view because it is poorly argued. Propose conclusive statements and write them on a flip chart in front of the group. These are the minutes and doing this will facilitate real-time consensus on ideas and decisions of the group.

Remember, time is the most valuable thing people have to give. Three things you can do to show you value people's time is start on time, end on time, and break on time. As the meeting leader, you are the host, and only you can manage the meeting and protect people's time. All will thank you for this in the end.

Closure: At the end of the meeting, cycle through the things that were captured on the flip charts. These are the products of the meeting. Determine what actions are appropriate. When an action item is identified, determine whose item it is. A good practice at the very end is to critique the meeting. This takes about 5 minutes, and allows everyone there to feel some investment in process improvement. Have someone transcribe those flip-chart notes and send them all to all present immediately.

I've found that when meetings are conducted this way people rarely leave feeling frustrated. If someone does feel frustrated, most likely it is not because of the meeting.

— Ray Morgan

Pathfinder Payloads

Mr. Steve Wegener, ERAST sensor manager from NASA Ames, is preparing two lightweight, high-performance instruments to use in Pathfinder initially for the upcoming science missions. Steve indicated that "we are getting very close to the day when ERAST aircraft and our small sensors will provide science data on demand, complementing what is now going on in space in a flexible and responsive way. We are prepared to meet the challenge." ERAST aircraft and sensors of the future could spend long periods of time over broad ocean areas monitoring storm developments to provide more accurate predictions of hurricanes and cyclones. These aircraft also could be used to monitor major croplands, forests and other large, remote expanses to provide early warning of crop damage or fires.

Source: Press release, AeroVironment (Monrovia, CA), 29 August 1997. Copy available from NASA Headquarters, NASA Historical Reference Collection (Washington, DC), File 18292.

NINETEEN

Home Field Advantage?

JENNY BAER-RIEDHART

PROGRAM MANAGER

NASA DRYDEN FLIGHT RESEARCH CENTER

Ironically, just as we were starting to demonstrate success with the Pathfinder project (i.e. flying higher, getting publicity for the aircraft, and gaining support at NASA Headquarters and in Congress for ERAST), the harder it was to operate out of our home base at the Dryden Flight Research Center.

Ironies are not always unexpected, however. I experienced something similar to this during a previous UAV program I had worked on. The culture at Dryden didn't value UAVs in the same way as the other aircraft there. At Dryden, traditionally, test pilots figured prominently in the programs, and here we were bringing in unpiloted planes. Understandably, there was some ambivalence, if not open resentment, towards a UAV program competing for precious airtime and flight resources. Still, it was disappointing.

That was strike one against us—and then there was strike two. Because of the nature of this Joint Sponsored Research Alliance, the private companies handled most of the flight activities; NASA engineers weren't directly involved. Dryden, thus, "hosted" the program, providing the facilities and some limited oversight and guidance, while the companies did the primary work. The attitude around the Dryden was, "Want to cut us out of the picture? Then do it all yourself."

Things never got openly hostile, but at the same time the message wasn't subtle. For example, when we needed to schedule flights, we were given limited times on the test range. With the solar-powered Pathfinder, especially, we had to have the right weather conditions and the right amount of time on the test range. The Pathfinder needed to fly at around 8 or 9 a.m. to take advantage of the sun and the wind conditions. Dryden wouldn't let us fly after 8 a.m. We could fly later on weekends, but we had to spend extra money to bring people in to support the activity.

The situation was exacerbated in other petty ways. We'd send a document for review, and it would never come back. I would schedule a meeting with Dryden personnel who needed to be there, and no one was available.

Our attention turned to Hawaii. Its islands afforded us a greater area of operability with less population below. Also, the wind environment was more favorable, and there was less competing air traffic. While it was just a matter of time before we left Dryden in any case, the problems there accelerated our departure.

TWENTY

Our Man in Kauai

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We'd chosen the island of Kauai because of the favorable conditions there for high altitude flight tests. To take advantage of these conditions, we had to overcome obstacles that were far more down to earth.

The residents of Kauai share a natural apprehension about outsiders. Visitors need to be wary of making an inappropriate (if unintended) impression. It helps to have someone willing serve as your entrée into the community. In that way, Dave Nekomoto was our man in Kauai.

Dave is a fourth generation Japanese-American, born and raised in Hawaii. He was a former Executive Officer at the Navy base where we were conducting the flight tests. Like many Kauaians we met, Dave had more than one job. Primarily, he was the manager for the local branch of a support contractor on the base. In addition, he worked with the Kauai Economic Development Board in trying to bring more technology-based jobs to Kauai. Officially, Dave became our "ace" chase pilot, flying a videographer-photographer to document the flights with air-to-air shots near the islands. More importantly, Dave introduced us to the unique culture of Kauai and the Pacific Missile Range Facility where we operated, and helped us "fit in" and establish a good rapport with the local community.

Dave was connected. Another of his regular occupations was serving as Director of Operations and helicopter pilot for a local land owner and sugarcane producer, Bruce Robinson. Dave flies helicopter tours over the island of Niihau,

owned by Bruce and Keith Robinson. We determined early on that Niihau was one of only a few options where our fragile aircraft could make a contingency landing on terra firma, which could mean the difference between recovery and loss of the Pathfinder if an emergency landing was required at some point. Dave smoothed the way with Mr. Robinson so that we had permission to land on Niihau if needed.

Though Dave considered this support part of his job(s), he made it clear that the real reason he did favors for us was because he liked us. That was a main ingredient we found in any business dealings we did on Kauai. It was a culture where your personality took you further than the size of your billfold. With Dave we endeared ourselves to him right away because, among other things, we devoured all the tasty food he and his friends Vince and Johnny cooked for us in their giant (and I mean giant) woks, and we sang with him. Yes, that's right—we sang.

Dave had—how shall I say it?—a thing for karaoke. Anybody who was tight with Dave spent time with him at his house singing. This was Dave's way of relaxing at the end of the day, and he had quite an elaborate set up at his place for it. Microphones, speakers, and acoustics that any garage band would kill for; plus, he must have owned the tracks for every song ever recorded. All you had to do was punch a button on a computer, and the music started up, with the lyrics flashed across a television screen. It was up to you to provide the vocals, and heaven help you if you were bashful.

No one on the Pathfinder team had a Sinatra voice, but we managed to get everyone to sing something. Even those who were painfully shy managed a few lines of "Happy Birthday." It was all in good fun, and more importantly, it showed that we had the "right stuff"—we weren't afraid to risk embarrassment, and we all trusted each other with our most important possession, our egos.

TWENTY-ONE

Hula Pie and Karaoke Nights

JEFFREY BAUER

CHIEF ENGINEER

NASA DRYDEN FLIGHT RESEARCH CENTER

Hula Pie is a desert at one of the restaurants near the hotel we were all staying at in Kauai. It consists of an Oreo cookie crust, macadamia nut ice cream, and four inches of whip cream. Everyone on the project who came to Kauai had to eat a piece of this pie. Call it an initiation, like singing karaoke, a hazing of sorts; it was the project's way of letting you know when you got off the plane that you weren't walking into this tropical paradise without paying an entry fee first.

I traveled to Kauai for the first time to attend an alliance meeting and to scout out potential operating locations. I spent my first two days there locked away in

Change of Venue

The right weather conditions are necessary for testing UAVs. Factors to consider include wind, turbulence, and cloud cover; therefore, although Pathfinder set its initial altitude record over Edwards AFB, its recent altitude attempt and subsequent success took the vehicle to the Hawaiian island of Kauai. There, operating from the U.S. Navy Pacific Missile Range Facility, the right weather conditions were found in conjunction with other operational requirements, such as airspace availability, adequate runway, low aircraft traffic, low frequency traffic, as well as the length of the solar day and sun angle (because of the lower latitude).

Source: John H. Del Frate and Gary B. Cosentino, *Recent Flight Test Experience with Uninhabited Aerial Vehicles at the NASA Dryden Flight Research Center* (Edwards, CA: NASA Dryden Flight Research Center, NASA/TM-1998-206546, April 1998), p. 4.

all-day meetings. Dave Nekomoto was there. Following the second day of meetings, he suggested that we go over to his house to sing karaoke.

Jenny had made it clear to all of the team that we needed to be sensitive to cultural differences when we were on the islands. But singing? I don't sing. "We have to go," Jenny told me. "And we're going to sing, too."

Anybody who was nervous about singing picked a song that everyone else knew. That way they could help you out. People who absolutely refused to do a whole song were still expected to sing one verse. One guy from AeroVironment sang so badly that everyone was rolling on the floor laughing. But he was one of the project leaders, and to show that kind of vulnerability, to stand up in front of his subordinates and look silly, that was a great exercise in team building.

What I found also was that it gave the project a history that people could cite whenever things were getting tense and we needed to remind ourselves of something funny. Someone might be stuck on a problem, but he could always turn to his colleague and say, "I'm stuck, but at least I don't sing as bad as you." They'd get a good laugh about that, and that was a nice break from dealing with the problem.

For many reasons, I could not possibly overstate the importance of these karaoke nights at Dave's place. The whole NASA and AeroVironment team was there, along with spouses, children, and other friends that had come over for a visit. It brought the team together and it made friends with our Hawaiian and military hosts. Dave invited folks from the base that we worked with each day and whom we never would have gotten to know personally otherwise. Without Dave's karaoke parties we probably still would have eventually been accepted by the community, but developing a social relationship certainly broke the ice and formed a basis of trust.

TWENTY-TWO

Sacrifices

DOUGAL MACLISE

PAYLOAD PROJECT MANAGER

NASA AMES RESEARCH CENTER

In Kauai, it was three weeks on, a week off, and that lasted for six months out of the year. When I got back home to California after three weeks away, somewhere within the first five minutes, my wife usually said, “You’re not doing this again.”

It was a difficult year for us because my daughter from my first marriage had decided she wanted to spend a year living with me before she went to college. That was the year I got the job on Pathfinder, so the time I spent in Hawaii certainly had its drawbacks. That may sound funny, like “Sure, it sure must be tough being stuck in paradise,” but when you have to be away from your family at an important time it doesn’t much matter where you are.

Steve Waggoner, one of the ERAST program managers, knew about my personal issues, and to say thanks for my commitment presented me with a beautiful picture of the Hawaiian Islands taken from the Space Shuttle. Things like this don’t make up for being away from your wife and kids, but it’s a nice way to say thanks for the sacrifice.

I decided that I should follow his example, and say thanks to everybody on my team by giving them some little token of appreciation. I had T-shirts made with a picture of a smiling sun and the Pathfinder airplane on one side and the words “Follow the Sun” in Hawaiian on the other.

TWENTY-THREE

The Expanding Sky

RAY MORGAN

FORMER VICE PRESIDENT

AEROVIRONMENT DESIGN DEVELOPMENT CENTER

CURRENT PROPRIETOR OF MORGAN AIRCRAFT & CONSULTING

To demonstrate the science payloads, we needed to fly over parts of Kauai within Federal Aviation Administration (FAA) airspace. The problem was that no one had flown an unmanned airplane outside restricted areas that the Pacific Missile Range Facility (PMRF) controlled.

To help us understand how to work with the FAA, we obtained the services of a retired FAA worker, Glen Witt, who understood the sensitivities of the operation and how to deal with the agency. We went with Glen to visit the local FAA offices, and we explained how the airplane worked and showed them pictures. Eventually, we developed a relationship with the office staff, but most importantly,

Glen served as our liaison with the FAA controllers in Honolulu during our flights on Kauai, which was a key to smooth operations. Without our liaison's help, I don't know whether we could have obtained FAA's approval to fly within their airspace. It certainly would have been much more difficult.

TWENTY-FOUR

Asking the Right Questions

DOUGAL MACLISE

PAYLOAD PROJECT MANAGER

NASA AMES RESEARCH CENTER

I grew up in a family of salesman, but until I joined the Pathfinder project I never realized how valuable my father's advice about sales would be. "Son," he said, "don't think a good salesman should be measured by whether he can sell ice cubes to an Eskimo. A good salesman is someone who finds out what the Eskimo needs and then sees if he has a product that will satisfy that need."

On our payload project, I had a chance to put his advice to the test. Ostensibly, the purpose of our project was to look at broad swaths of vegetation on Kauai from our high-altitude perch on Pathfinder. By the brightness of the infrared bands in the images we captured, scientists could see how healthy plant life was, and, while we were in the air, instruct us to fly over different areas and take more pictures.

To help scientists understand the potential value of our data to them, I went on marketing trips around the islands. I met scientists who had no idea about aerial photography and what it could do for them. I tried to explain to them how chlorophyll reflects infrared more than it reflects green, what the camera was capturing, and how it showed the stress of the plants. My other objective was to look for new ideas, new ways to use our information. For example, we planned to take pictures of the forests to collect data on agriculture. Then we met somebody who was talking about mapping roads. Suddenly we were aiming our camera at the roads, too.

Building on earlier visits to sugarcane producers, I went for a ride with one in his helicopter and took pictures of crops to demonstrate the value of the project and to whet his appetite for wider-scale images available from Pathfinder. He pointed out areas where he wanted me to take pictures as we were flying. Later, when I showed him the pictures, he pored over them. Within a day he was using the information we'd collected to fix broken irrigation lines. Word of that got around to other parts of the community, for example to the coffee growers, who began to see how useful aerial photography could be to them. It led to some of the work that's going on now.

Normally, the customer gives you money in exchange for something you give him. These people weren't giving us money, but they're the users of the information we could provide to them, and so we collected their needs.

The reality is that every year you have to defend your program. Every year, people are proposing new programs. The best way to keep a program alive is to get the user communities to say they need the data your program provides them. Thus it behooves you to spread your base of support far and wide.

TWENTY-FIVE

Head Over Heels

JENNY BAER-RIEDHART

PROGRAM MANAGER

NASA DRYDEN FLIGHT RESEARCH CENTER

In planning our marketing strategy on the islands—yes, we had a marketing strategy—we developed educational programs in the schools and put together displays at the local museum. We helped to write the lesson plans, and NASA public affairs staff led training workshops for the teachers to show them what we were doing, so that they could share this information with their students.

We involved the Kauai Community College by hiring students to work for us at Pacific Missile Range Facility (PMRF) and introducing them to advanced solar technology. This was done on Dave Nekomoto's advice, and he put us in direct touch with the right people at the college—it helped that his brother-in-law was the Dean of Instruction there.

From Dave we learned invaluable things about Kauaian culture—for instance, the high regard Kauaians have for those who educate their children. Working with the base commander and the PMRF public affairs office, the NASA and AV team orchestrated an open house that brought in approximately 1000 local schoolchildren to see the Pathfinder, its payloads, and key parts of the PMRF support equipment. We jokingly called this event the “1000-Kid March,” and the name stuck. It was tremendously successful, and students and teachers from across the state participated.

Dave was also quick to let Hawaii's political machine know what was going on with our project at PMRF, which resulted in Hawaii's entire congressional delegation sending a letter to NASA commending us on the success of our program. Suddenly money that hadn't been available before appeared and this gave the project some extra lift, so to speak, making our attempts at another world-record-altitude flight an even more viable goal.

The community, to put it immodestly, fell head over heels in love with us. “This Pathfinder is a good thing,” people were saying. “These people are doing something special.” That kind of talk has a way of making things happen. People on the island that worked at the places we stayed, the places we ate, and the airline and car rental agencies all got to know many of the team. When we had to make travel arrangements that were subject to change with events in our flight schedules, this relationship proved invaluable.

Many times in our projects we think that just being smarter than someone else or having the best idea is all we need. That helps, no doubt, but you've got to understand the human side of things. We came to Kauai not knowing how the human dimension would figure into our activities, but we understood that however it worked itself out was going to be critical to our success. That's why we set aside money in our budget specifically for the kinds of activities described here. Call it marketing or public relations, but whatever you call it, by the time we left Kauai, we had probably spent 20 percent of our project time on it.

TWENTY-SIX

Bringing Out the Best in Us

DOUGAL MACLISE

PAYLOAD PROJECT MANAGER

NASA AMES RESEARCH CENTER

As a project manager, you want to give your team as much flexibility as possible to solve problems. I took great pains to select my team, and I trusted and respected every one of them. So, when it came time to work, I let them do what they needed to to get the job done. That's how I honored the trust that I had placed in them.

Sometimes it isn't easy, but when you need creative problem solving on a project, you have to resist the urge to control. For example, we needed a faster Internet connection than was available to us at the test site. Flight tests took place in Hawaii at the Pacific Missile Range Facility (PMRF) on the island of Kauai. They were going to provide us with a 9600-baud modem. An 18-megabyte image would take 4 hours to download. We probably had 6-8 hours of flight time, which meant that we could only download one or two images per flight. That wouldn't work.

Teammate Stan Ault volunteered to take on the challenge. He had a concept for converting the digital image data into a barcode that he could encode into a video signal that could be captured and de-converted on the ground. I told him I would gladly leave the details to him.

Good thing, because his solution involved using the plane's video link—the only visual link that the flight crew had to the plane during most of the flight. For us to download an image, the flight team had to switch their video transmitter over to our payload and take it off the video camera they were watching. During that time they had no way to visually monitor the plane. It was like asking a pilot to close his eyes for about five minutes of a flight.

At the other end of the network, we needed a server that the public could connect to on the Internet. PMRF had a strong firewall, and they weren't going to allow anyone from outside to get through, so we didn't have the option of putting a Web site on a computer at the base. I handed this problem over to teammate Don Sullivan.

Don was an expert in networking and computer applications. He researched the local Internet connections and found that they were extremely complicated and fragile, but he was able to convince PMRF to set up a connection for us through their firewall that we routed back to a server at Ames Research Center in California. The route was to go from Kauai to Maui via Honolulu and then to the mainland by an underwater cable. It was all very complicated, and on the day before the flight there was a fire under the streets of Honolulu that burned part of the Internet link. Fortunately, Don had it under control, but it was one of those close shaves where keeping me ignorant was in the best interest of the project simply because it was in the best interest of my health.

When Don told me about the fire, I said, “What happened to our plan about not telling me what I don’t need to know?” The saying goes “ignorance is bliss.” Well, I gladly stayed ignorant of some of the details, knowing that I could trust my team to keep me informed when I needed to be—but to be honest, totally honest, I rarely felt anything remotely close to bliss.

ARTIS

ERAST team members at the Ames Research Center plan to fly a sensor package on Pathfinder during these flight tests which will acquire both real-time video images and high-resolution “snapshots” from a 6-megapixel digital color camera. Both of these cameras will be pointed downward to provide color images of the ground in the visible and near-infrared wavelengths. The images will be telemetered to a ground station during the flight. Because these images will provide visual cues as to the whereabouts of the aircraft independent of the vehicle’s navigational system, the payload is referred to as the “Airborne Real-Time Imaging System,” or ARTIS.

Source: National Aeronautics and Space Administration, Ames Research Center, “Artis: Airborne Real-Time Imaging System” accessed at <http://geo.arc.nasa.gov/ERAST/pathfinder/kodak.html> on 27 October 2004.

TWENTY-SEVEN

PERT Charts Take Precedence

RAY MORGAN

FORMER VICE PRESIDENT

AEROVIRONMENT DESIGN DEVELOPMENT CENTER

CURRENT PROPRIETOR OF MORGAN AIRCRAFT & CONSULTING

Managers need to effectively communicate people's roles on a project. In fact, this is one of the primary jobs of a project manager, and most of the tools available for project management are really forms of communication.

From the standpoint of communicating the overall picture of what needs to be done, when and why, to both the project team and our customers, however, I've found the PERT chart (PERT stands for "Program Evaluation and Review Technique") to be extremely helpful in the effective execution of the project.

We put our chart on the side of a large container right in the hangar, next to the flight test crew and the airplane. When posted, it becomes a valuable, graphic depiction of the work plan, interdependencies, milestones, and people on the critical path (as well as which ones may need help). It also allows the team to mark it up interactively, adding tasks that come up when necessary and checking-off tasks as they are completed. We usually incorporated these changes into a computer model and reprinted it once or twice a week during flight tests.

The chart was much more than window dressing, as we often referred back to it in team meetings to help redefine the importance of a current task and to see how it fit into "the big picture." This became a critical tool for the team. Enthusiasm for accomplishing the next goal was reborn each time we looked at the graphics on our wall. The fact that these charts were actually updated, and did not just become faded wallpaper, validated them to the team.

See PERT charts created by AeroVironment at end of chapter. These charts trace the evolution of the ERAST program beyond the Pathfinder project, and include Pathfinder Plus and the Helios Prototype.

TWENTY-EIGHT

Do or Die

DOUGAL MACLISE

PAYLOAD PROJECT MANAGER

NASA AMES RESEARCH CENTER

At our flight readiness review the day before we were scheduled to fly, I had to stand up and say, “We need a flight to know if we’re ready.” Nobody liked the sound of that, especially the people from AeroVironment, whose Pathfinder was carrying our payload. We were committed to a full day of flying whether the payload worked or not, and I knew it would be a long day if things didn’t go our way. There would be several hours of wallowing in our failure.

We had tried mimicking the system on the ground in several ways and could not do it. One of the problems we couldn’t solve till the end involved some glitches with the software on the payload computer. The only solution we had was what we called a therapeutic reboot, much the same thing you do on your home computer when a software application causes the system to crash—you turn off the machine.

On the day of the flight, the morning sky was clear and beautiful. On the runway, as the plane was being rolled out, we tried to take a picture and the system crashed. We rebooted and prayed for better luck when we were in the air. Finally, just after take off, we managed to get a picture and were able to put it on the Internet in about 20 minutes. Everyone—and I mean everyone—breathed a sigh of relief, although I still kept my fingers crossed.

Things seemed to be going fine once we were in the air. Still, my stomach was in knots. Now and then the payload would hang, and all we could do was tell the pilot to do the therapeutic reboot. We were flying at 30,000–40,000 feet, much lower than the high altitudes Pathfinder had reached when it set a world altitude record. A 17-pound payload doesn’t sound like much, but the plane itself without the payload weighed a grand total of 500 pounds. So, it’s like the mountain climbers say, “Every ounce counts.”

We managed to get 16 pictures altogether. We learned where to go to get a shot of a broken irrigation line, where an outbreak of something was occurring, where there appeared to be an immature crop or anything else that someone asked to see. On our Web site, the images showed up as dots on a map. You clicked on the dot and this brought up the picture. We were able to get the images up on the Internet in just under 20 minutes. Not bad. No one was complaining that we were too slow.

As night fell, it looked as though the mission was over, and I thought the high drama was ended for the day—but that was premature. On the way back to the Pacific Missile Range Facility the winds didn’t die down as expected. The sun having set, the plane had switched to battery operation, and couldn’t stay up indefinitely. The pilot did a swing out over the breakers and there was very little wing space between the water and the wing tip. In the last 50 feet the winds died

Community Involvement

Mr. David Nekomoto, PMRF Test and Evaluation contractor, cited that “the ERAST team has brought new meaning and importance to the Hawaiian Islands. By working side-by-side with ERAST personnel, local Hawaiians are gaining an appreciation and valuable insights into new business areas much sought after by the state. We are very appreciative for NASA providing us a role in history being made in aviation and science. We need more programs like it.”

Source: Press release, AeroVironment (Monrovia, CA), 29 August 1997. Copy available from NASA Headquarters, NASA Historical Reference Collection (Washington, DC), File 18292.

down enough for him to land. How close we’d come to losing the plane I don’t think anyone dared to contemplate.

Once we got the plane back in the hangar, we were all wrung out emotionally from the long day. Everyone wanted it to be over with. Yet there was one requirement still to meet—the celebration. Once again, we had a clear objective and almost any plan to get there would suffice.

TWENTY-NINE

Flight Party

RAY MORGAN

FORMER VICE PRESIDENT

AEROVIRONMENT DESIGN DEVELOPMENT CENTER

CURRENT PROPRIETOR OF MORGAN AIRCRAFT & CONSULTING

After a successful flight test, it’s a tradition to throw a party. The project manager buys the refreshments, usually a couple of kegs of beer, and that is how you pay back your team. After Pathfinder set the world altitude record on 7 July 1997, we decided to throw a different kind of party. We invited everyone we could, our community of friends and supporters, and it turned out to be one of the biggest bashes they’d ever seen on the island.

We held the party in a park, and had flyers printed up and sent out special invitations. AeroVironment had T-shirts made that said “Thank You” in Hawaiian. I had NASA stickers and ERAST stickers to give to people. There was singing and hula dancing. Dave Nekomoto brought a karaoke machine. The reigning Miss Hawaii even showed up and sang for us.

People who worked with us from the Pacific Missile Range Facility came, too, and they brought anyone from the base who wanted to be included, electricians,

telephone repairmen, even janitors. They never had a celebration like this before, and were glad to help out with things like the cooking.

Teachers, school kids, and community college students came; we had done so much educational outreach they wouldn't have missed it for the world. Kauai Community College puts it in its promotional brochures now that their students worked on the Pathfinder project, and students apparently have enrolled there just so they would have the chance to apply for a job with the ERAST program.

The party started at 3:00 in the afternoon and didn't end until well past midnight. Ostensibly, it was to celebrate the altitude record, but it was also just to say thank you to the community for all the help they gave us. The most memorable thing about the party for me was how happy they were that we had done this for them. By the time we left, every Kauaian knew about Pathfinder and what we were trying to accomplish—and, more importantly, they were behind us 100 percent, and so we wanted everyone to feel like they were part of the team. And they did. If you look around the island today, you'll still see people proudly wearing their Pathfinder T-shirts.

Cynics will look at our public relations activities on Kauai and say that all we did was woo the natives to get what we wanted from them. For those inclined to see the world this way, you can bet they make little distinction between a friend and an asset. The way I see it, we had friends on the island; if they were assets, too, that's beside the point. We enjoyed sharing our accomplishments with everyone who wanted to be part of the team. The world record belonged to all of us.

A lot of factors contributed to our success in the skies above Kauai. One very important factor was that the people of Kauai felt invested in our success and wanted to do whatever they could to help us reach our goals. Whatever advancements derive from our work on Pathfinder, the support of the Kauaians who helped make it possible must never be forgotten.

Bottom line, none of us can do much alone. People are the most important part of any operation, and it is only with the help of others that we do great things. It is important that we recognize our interdependence in any enterprise, and the earlier we do it, the easier things are, and the better they work.

THIRTY

A Star is Born

JENNY BAER-RIEDHART

PROGRAM MANAGER

NASA DRYDEN FLIGHT RESEARCH CENTER

When Pathfinder reached 71,530 feet, it shattered its own high altitude world record for solar-powered aircraft. Though this was a major milestone, not only for the program but also for the fields of solar technology and environmental imaging, it was apparently not an important news story to the Agency.

We were bumped off of NASA-TV and off the press releases that went out for that day. The big news out of the Agency was the other NASA Pathfinder project, the one that had landed on Mars three days earlier. We were delighted for our friends over at the Jet Propulsion Laboratory who were celebrities around the world, but we were still disappointed that we didn't merit a mention.

After that we said, "Okay, we have to find another way to sell ERAST and keep up our visibility." We involved the members of the alliance in this discussion because it affected all of them, not just AeroVironment. Since ours was a partnership between industry and NASA, and NASA wasn't getting the news out, we agreed to make industry the lead on getting our story out to the nation.

We brought a professional on board who worked directly with the media by feeding stories and information to them on our major activities, such as the flight tests. He got us a lot of press and publicity, including getting us on all the major networks.

This was unique for a NASA program. For the other Agency programs I had been involved with, NASA did its own public relations work. In our case, the alliance members gave back \$10,000 of their funding to pay for the work of an independent publicist, and our NASA program office kicked in another \$10,000.

The way I look at it, if you use public money to do this sort of work, you have a duty to spread that news to the public by whatever means you have available to you. In terms of the impact on your program, don't underestimate the value of exposure. When bills come up in Congress for funding, people call their congressional representatives and ask them to promote a program. ERAST got written into bills because of the accomplishments of the solar-powered aircraft, and this came about largely because of the national exposure we received through the media.

THIRTY-ONE

Niche Players

BOB WHITEHEAD

ASSOCIATE ADMINISTRATOR FOR AERONAUTICS

NASA HEADQUARTERS

The President wants to balance the budget. And, by the way, NASA, you need to kick in your fair share. It would have been easy to cut ERAST, a measly \$50 million program. Who was going to squawk—Jenny, Dryden, AeroVironment?

If I deserve credit for anything, it's for protecting the ERAST bunch once they were a proven commodity. Dollar-for-dollar, nobody produced more visible results and more excitement than those folks. I was a bureaucrat and a NASA executive, but I knew a good program when I saw it

If I became an advocate for ERAST—and I did—it was not an emotional issue for me. The decision to protect them was easy. We were getting the benefits of their performance. They may be niche players, but they were my niche players, and they were performing. That's what they paid me to do, to make decisions based on impact.

Of Milestones Made and World Records Achieved

On 7 July 1997, the "Pathfinder" solar-powered, remotely-piloted aircraft flew to an altitude of 71,530 feet and returned safely to the Pacific Missile Range Facility at Barking Sands, Kauai, in the Hawaiian Islands. Total flight time was 14 hours and 31 minutes, of which 1 hour was spent above 70,000 feet, 3 hours above 60,000 feet, and nearly 5 hours above 50,000 feet.

Ms. Jennifer Baer-Riedhart, the NASA ERAST Program Manager, stated that "Pathfinder's performance to date has exceeded our wildest expectations. We beat our altitude milestone by 6,500 feet in the first two flights and demonstrated the capability for science mission demonstrations in two more sequential flights—all within three months and in a remote, tropical location. Our team performed without flaw, and way ahead of schedule. I am proud to be part of a world-class team led by AeroVironment and supported by our Hawaiian counterparts. We have set a very high standard for others in our ERAST team to follow."

Source: Press release, AeroVironment (Monrovia, CA), 29 August 1997. Copy available from NASA Headquarters, NASA Historical Reference Collection (Washington, DC), File 18292.

Reaching Greater Heights

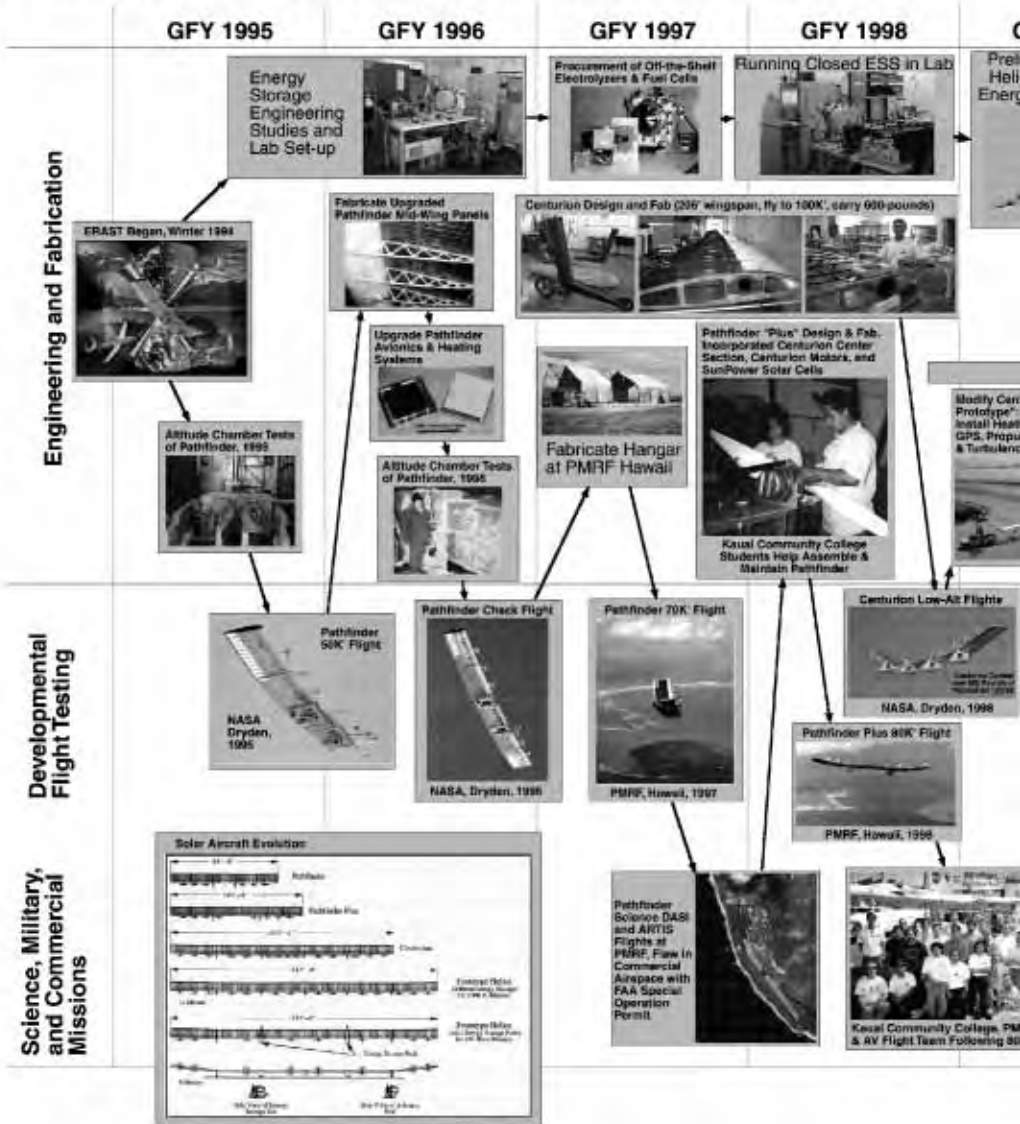
The first unmanned solar airplane developed under the NASA program, the Pathfinder, flew to 71,500 feet in 1997. A modified Pathfinder, known as Pathfinder-Plus, flew to 82,000 feet, higher than any other propeller-driven aircraft. This record flight was the 39th consecutive successful flight test of the Pathfinder platform.

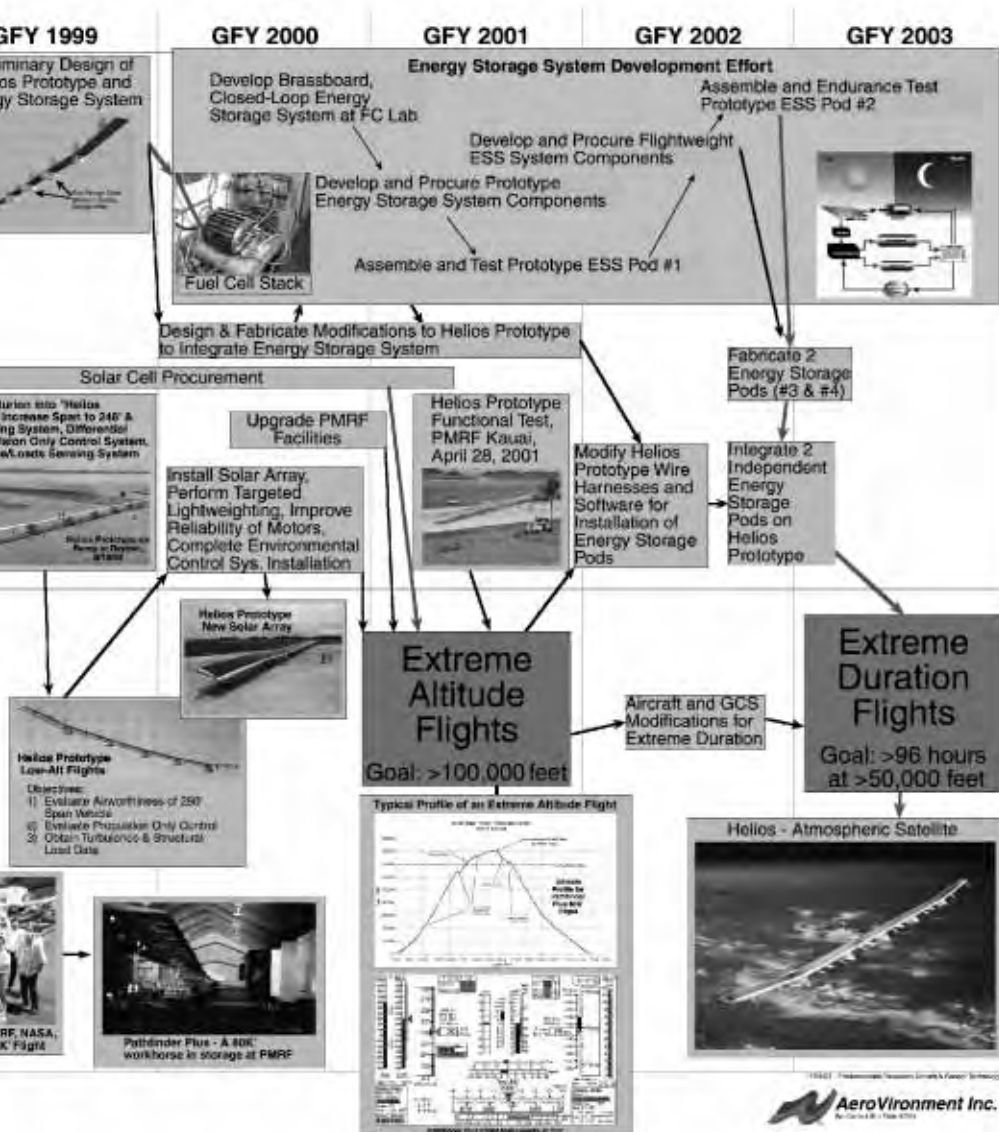
Building on Pathfinder's success, AeroVironment built a next-generation aircraft with a 206-foot wingspan, called the Centurion, which was test flown in 1998 at Edwards Air Force Base. The wingspan was then further extended to 247 feet, and the aircraft was renamed the Helios Prototype. The Helios Prototype, which successfully completed initial low altitude flight testing at Edwards Air Force Base in 1999, was then equipped with high efficiency solar cells and underwent high-altitude flight testing in the summer of 2001 in Hawaii at the U.S. Navy Pacific Missile Range Facility in Kauai. On August 13, 2001 on its second high altitude flight, Helios flew to 96,863 feet, shattering the world altitude record for both propeller and jet-powered aircraft (the SR-71 spy plane was the previous record holder, having flown to 85,068 feet in July 1976).

Source: "Unmanned Aerial Vehicles," AeroVironment. Accessed at <http://www.aerovironment.com/area-aircraft/unmanned.html> on 27 October 2004.

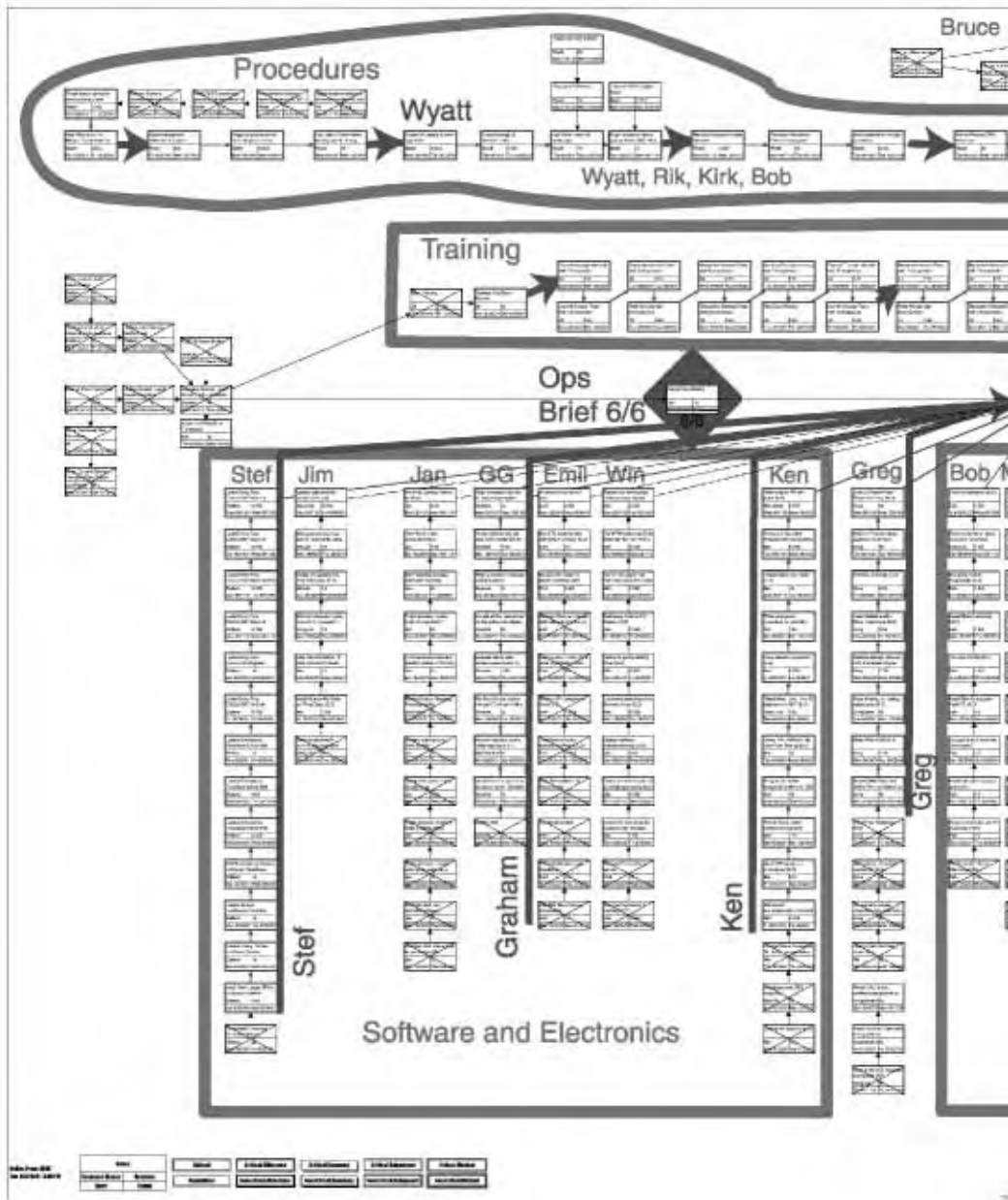
NASA ERAST Solar Aircraft Development Plan: An Overall Plan

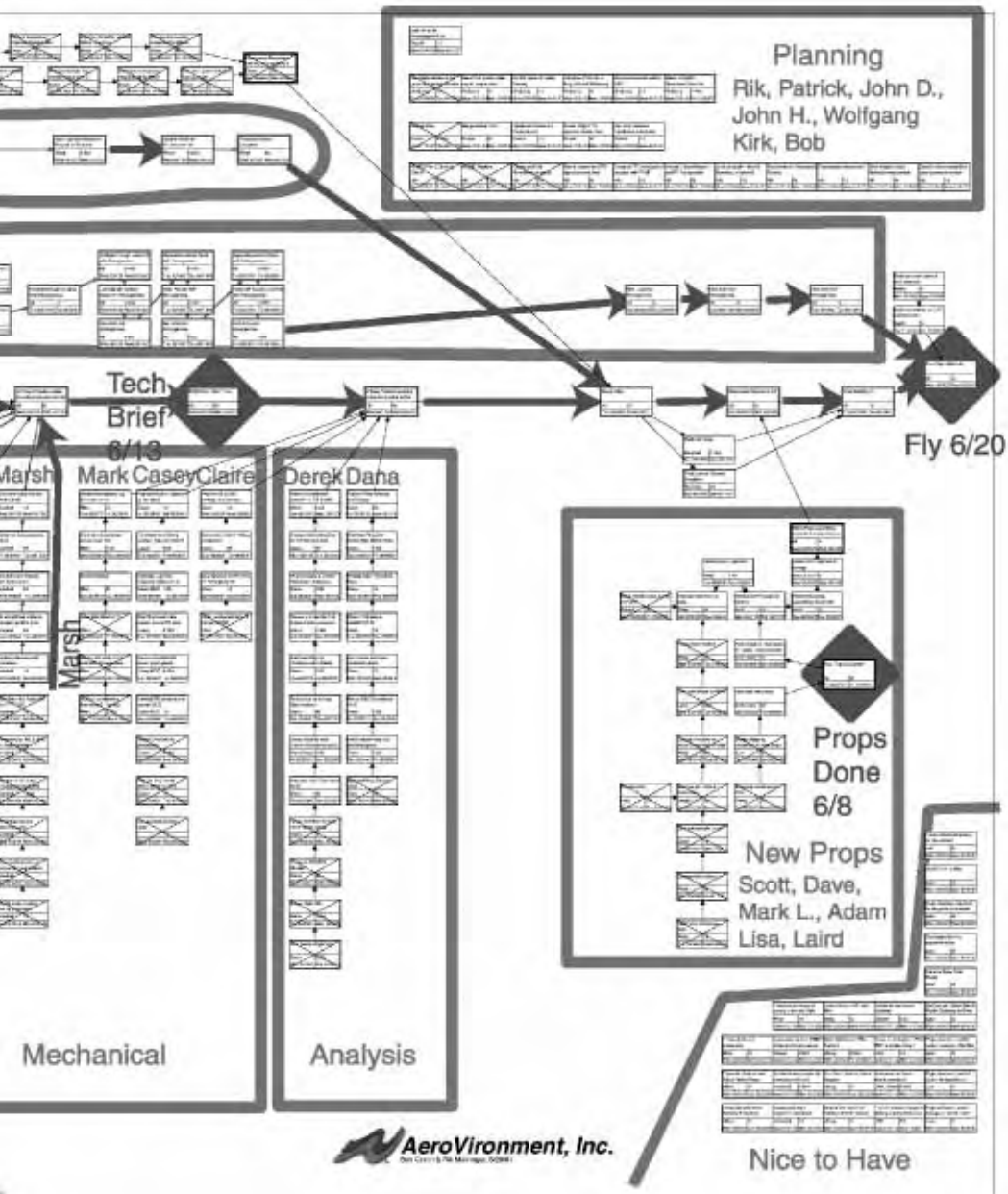
NASA ERAST* Solar Aircraft Development Plan



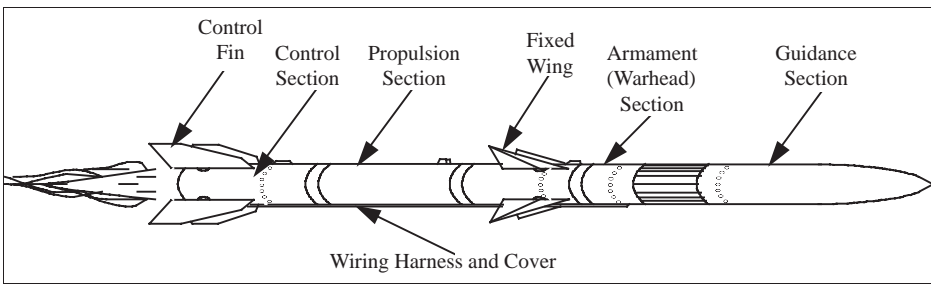


NASA ERAST Solar Aircraft Development Plan: A Detailed Plan





SHAKING HANDS AND SHAKING THINGS UP: AMRAAM



ADVANCED MEDIUM RANGE AIR-TO-AIR MISSILE

In the summer of 1997, Judy Stokley took over as Program Director of the Air-to-Air Joint System Project Office (JSPO) at Eglin Air Force Base in Florida. As the JSPO Program Director, Stokley focused much of her attention on reforming the Advanced Medium Range Air-to-Air Missile (AMRAAM) program, which had been operational since 1991 and was being produced for the Air Force, Navy, Marine Corps, and many international customers.

The program was rife with problems when Stokley arrived. Two of the most pressing problems included a bloated Average Unit Procurement Cost and an Air Force mandated drawdown plan that had not been met. She also discovered that not everyone at Eglin was keen on change. Motivated by a desire to do the right thing, despite strong pressure to maintain the status quo, Stokley soon found herself in the center of a maelstrom. The reforms she had in mind entailed a partnership with industry that was dramatically different than the management path they were on.

Shared Voyage: Learning and Unlearning from Remarkable Projects

Recognizing that change would require more than leadership skills alone, she cultivated the cooperation of change agents within her organization and her industry partners. These were people who realized it was necessary to do business a better way for the good of both industry and government. The problem was that the program had existed for almost 20 years, and a mindset had formed around it that was hard to break.

SOURCES:

U. S. AIR FORCE

Judy Stokley, Program Manager
George Sudan, Chief Engineer
Dennis Mallik, Chief Financial Officer
Diane Steeg, Infrastructure Support
Col. Wendy Massiello, Contracting Officer
Jerry Worsham, Chief of Logistics
Maj. Andrew Beaudoin, Engineer
Jon Westphal, Engineer

RAYTHEON

Chuck Anderson, Vice President
Tom Gillman, Contracting Officer
Brock McCaman, Program Manager

ONE

Draw Down and Fall Out

JUDY STOKLEY

PROGRAM DIRECTOR

U.S. AIR FORCE

August 1997, Eglin Air Force Base: I called a meeting of everyone—civil servants and contractors—who worked on the Advanced Medium Range Air-to-Air Missile (AMRAAM) program. I had become the new program director of AMRAAM a couple of months earlier, after serving as director on another program at Eglin. Though my old program was small by Air Force standards, I had won praise for taking an innovative approach to leading the program and for making difficult decisions. My reward was AMRAAM.

Talk about a difficult start. Imagine getting up in front of 200 people and telling them that in less than a year most of them would no longer be working in your program office. I've always done everything that the Air Force has asked me to do, and if they asked me to do a massive downsizing again, I know I would do it; but I pray to God that they find someone else. I've done this once, and I don't ever want to do it again.

The Air Force had issued a mandate to draw down the workforce, and everyone on the program knew about it—civilians, military personnel, and support contractors. A lot of these people had been on the program for the full 20 years it had existed, and many thought they were going to stay there until they retired. The program director before me had not been able to face letting people go. He had told me this while I was his deputy. "I would rather retire than let that many people

Who Says Draw Down?

While there have already been reductions in the acquisition workforce, continuing reduction in both military and civilian personnel (active duty reduced by 520,000; civilians by 200,000) and the need to reduce DOD's infrastructure mean that there will be further reductions in the acquisition workforce. DOD cannot accommodate these reductions without making changes in the current acquisition process. It must reduce the cost of the acquisition process by the elimination of activities that, although being performed by many dedicated and hardworking personnel, are not necessary or cost-effective in today's environment.

Source: "Acquisition Reform—A Mandate for Change," Policy Paper, Secretary of Defense William Perry, 9 February 1994. Accessed at http://www.cadv.org/pdf_docs/mand24.pdf on 30 September 2004.

go,” he said, and that’s what he did—so there was a perception in the program office that perhaps we would be able to “escape” compliance with the directive.

“We are going to do this drawdown, and we are going to do it in one year,” I said at the meeting. “We are going to be down to less than 100 people, and probably as low as 70 or 80 people, in this fiscal year. I believe this is a good thing for our country and the taxpayers, and ultimately it will be a good thing for you.”

I tried to make it clear that I didn’t intend to just “pink slip” people—good-bye, good luck, and get out of here. We were going to be systematic about trying to find them work, both the civil servants and the support contractors. That was not something they took to heart right away, and that was understandable. Until you see it happening around you, it is hard to fathom that the people who are letting you go are going to help you find another job.

I invited them to ask questions, and there were none. Not a murmur. The room went silent—dead silent—after I spoke, but the moment the meeting ended, people gathered around me and their voices competed for my attention. Each of

AMRAAM Facts

AMRAAM is a supersonic, air launched, aerial intercept, guided missile employing active radar target tracking, proportional navigation guidance, and active radio frequency target detection.

The AMRAAM weighs 340 pounds and uses an advanced solid-fuel rocket motor to achieve a speed of Mach 4 and a range in excess of 30 miles.

With its sophisticated avionics, high closing speed, and excellent end-game maneuverability, chances of escape from AMRAAM are minimal. Upon intercept an active-radar proximity fuse detonates the 40-pound high-explosive warhead to destroy the target. At closer ranges, AMRAAM guides itself all the way using its own radar, freeing the launch aircraft to engage other targets.

The AMRAAM program was established as a result of a Joint Service Operational Requirement for an Advanced Air-to-Air Tactical Missile needed in the post-1985 time frame.

AMRAAM is managed as a joint Air Force and Navy program. The Air Force, as executive service, established a Joint System Program Office (JSPO) at the Air Force Material Command/Aeronautical Systems Center, Eglin Air Force Base, Fort Walton Beach, Florida.

Source: U.S. Air Force, Air Combat Command Public Affairs Office, “AIM-120 Fact Sheet,” April 2003. Accessed at <http://www.af.mil/factsheets/> on 30 September 2004.

them tried to convince me that if I would just take the time to understand how they contributed to the program, I would see that we couldn't do without them.

It was neither pleasant nor easy. On a personal level, I never experienced anything like it before. I had to deal with people whispering behind my back when I walked past them. It was the first time in my life that I experienced being disliked and gossiped about, and let me tell you, there is no pleasure in knowing that you are being blamed for other people's pain.

TWO

Someone Has to Get It

GEORGE SUDAN

CHIEF ENGINEER

U.S. AIR FORCE

I joined the AMRAAM program when it began in 1975, and I stayed there for the most part until I retired from the government in 2001. There was a stretch of a few years during the early '80s where I left to work on another program, and this was quite an enlightening time for me. It was then that I learned that acquisition reform doesn't have to be a pipe dream.

The program I went to wasn't as big as AMRAAM, but it was a complicated weapons system just the same. For the longest time it seemed as though no one could figure out how to get the weapon to fire correctly. People were fond of describing it as "eight miracles needing to happen at once." You get the picture, I think.

One of the reasons the system wasn't working was because government engineers were busy meddling with the contractor. We had individuals on our team who felt that their primary responsibility was to criticize the contractor and tell them how to do their job. We don't do engineering very well in the government anymore, we haven't for many years, but we do have a lot of people who like to dabble in it, and that's what they were doing.

I learned early on that there are not enough hours in the day to try to keep up with the contractor on a technical basis. The contractor has the best people in the world working for him. The role of a government engineer should be to put together performance specifications. After the specs are written, signed off, and part of the contract, then his job as the customer is to make sure that the contractor is building the system that has been specified.

With the support of my management, I was able to get our engineers out of the meddling business and into the specifications and verification business. As for what happened with regard to the "eight miracles," before long—surprise, surprise—we were able to turn things around and get the system to work.

In the early '90s, after I had rejoined AMRAAM, I talked with my management there about my experience in the other program, but it was as though my words fell on deaf ears. They thought I was out of my mind.

"You can't trust these dirty contractors. They're all out to take advantage of you," they told me.

They expected us to line up with the contractor as though it were a basketball game. Here's their radio frequency guy, so we've got to have a radio frequency guy. Here's their software guy, so we've got to have a software guy. If he fakes left, you fake left. For our part on the government side, we were harassing our "opponents" all the time. "Let me see your documents. Let me review this. Let me see how you did that."

Without management support behind me, it was impossible to change the status quo. Not until the congressional mandates started coming down did people show any kind of interest in reform. The door opened a little and some superficial fat was cut, but it was clearly not the kind of serious reform that was needed.

Yes, I was glad when Judy Stokley arrived at AMRAAM. I knew her before she took over as the program director. We had worked together on another program for a while, but we had never had a close working relationship, not like the one we developed on AMRAAM. She seemed to understand that acquisition reform—real reform—entailed something more significant than the cosmetic changes I had seen thus far. Still, I wondered whether anyone, no matter how dedicated they were as a leader, could change the status quo and bring about serious reform.

THREE

The Secret Inside My Desk

DENNIS MALLIK

CHIEF FINANCIAL OFFICER

U.S. AIR FORCE

We talked about acquisition reform in the AMRAAM program office for some time before Judy Stokley took over as program director. In the early 1990s, her predecessor asked me to do a cost study on how to save money. I did it and produced a report, but he told me to take that report, lock it up inside my desk drawer, and make sure it stayed there until our base commander either transferred or retired.

No one needed a study to see that the AMRAAM program was spending too much money. Here's an example: we had five separate simulation models checking the performance of the missile. Our two contractors (Hughes and Raytheon) each had a simulation model, the Navy had its model, and then there were two independent simulations done at Eglin Air Force Base.

One of the simulation facilities at Eglin had been with the program from the beginning, but the other was brand spanking new. AMRAAM was the primary contributor to that facility. While we may have needed the government simulations when we were still a research and development effort, once we began manufacturing missiles you have to question the need for that much expensive redundancy. It was the folks who were building the missile, the contractors, who needed the data, and they were getting that at their own facilities.

When Judy Stokley became program director, I understood immediately that it was time to open up my desk drawer and dust off that report. Ms. Stokley is what we call a “quick study,” so it didn’t take long for her to figure out what was going on. Her reaction was very different than her predecessor’s. “Why, we’ve got to get this information out to people,” she said. To many of us who had given up hope that real reform was possible, we knew that we had seen the dawn of a new day.

FOUR

Pageantry

GEORGE SUDAN
CHIEF ENGINEER
U.S. AIR FORCE

For years I looked around and wondered why AMRAAM was supporting so much of what I called “pageantry.” Why were we sinking money into a test facility when the contractors had a facility, or two facilities, that put ours to shame?

Sure, you need to test, but how much do you need to test, what do the tests need to prove, and when do you know that you’ve tested enough? These are decisions that need to be made by hard-nosed technical management people, not by bureaucratic consensus. Consequently, I was frequently at odds with the test guys. It got to the point where they used to stencil my name on the tail of the target drones.

FIVE

Task Destination

JUDY STOKLEY
PROGRAM DIRECTOR
U.S. AIR FORCE

If you are going to draw down the workforce, you ought to do it quickly. Analyze what people are doing and communicate a scheme for reducing the work. You can do it slowly, but that seems to me like leaving yourself in a state of constant bleeding. My view was to do the amputation, and then let’s get well.

I decided up front that we were going to analyze all our tasks and be finished with the draw down in six months. I needed a process that would be perceived

as reliable, fair, and quick. From my earliest intimations that I was intending to reform AMRAAM, I was under constant scrutiny by my upper management who favored the status quo.

“Task Destination” was the name I came up with for this activity. I put together a small team, and together we asked, “What is it that needs to be done?” And then we asked, “Okay, who ought to do it? Is that inherently a government function, or is that something that ought to be done by the contractor? Or is that something that is a legacy or artifact of some other part of the program that doesn’t need to be done any longer?”

George Sudan led this activity. I asked George to be the lead because when I briefed my management about what was happening, I wanted them to know that my chief engineer, the technical lead, was deciding which technical positions were going to be eliminated. I knew that their big concern was that we were ceding too much of our technical responsibility to the contractor. In that case, let the chief engineer make the call on what made sense for us to do and what made sense for the contractor to do.

Everybody in the program office did a worksheet and put down their task, what their product was, when their deliverables were due, and who their customers were. One of my ground rules was that no one was exempt, including my deputies. The four chief engineers—from Hughes, Raytheon, the Navy, and the Air Force—sat down together and interviewed each person. We did this so that everyone felt that they were communicating their job to the right people.

Beginnings

The AMRAAM program completed its conceptual phase in February 1979 when the U.S. Air Force selected two of five competing contractors, Hughes Aircraft Co. and Raytheon Co., to continue into the validation phase. During the 33-month validation phase the contractors continued missile development by building actual hardware to demonstrate their technological concepts. The program phase concluded in December 1981 after both contractors demonstrated that their flight-test missiles could satisfy Air Force and Navy requirements. The Air Force competitively selected Hughes Aircraft Co.’s Missile System Group, Canoga Park, Calif., as the full-scale developer. During the full-scale development phase, Hughes Aircraft Co. completed missile development and Raytheon was selected as a follower producer. A production contract to both vendors was awarded in 1987.

Source: U.S. Air Force, Air Combat Command Public Affairs Office, “AIM-120 Fact Sheet,” April 2003. Accessed at <http://www.af.mil/factsheets/> on 30 September 2004.

The chief engineers were expected to make recommendations on the disposition of each task to the four heads—that was me, my deputy, and the vice presidents from the contractors, Raytheon and Hughes. We either agreed or disagreed with the recommendations. In every case that I recall, we agreed with the recommendations. When we were done, our program office team shrank from roughly 200 people to 68.

SIX

True Believers

GEORGE SUDAN
CHIEF ENGINEER
U.S. AIR FORCE

We probably could have completed the Task Destination in a couple of days. Those of us who had been around long enough knew what had to be done. Instead, we spread it out over six months. Judy wanted to be completely open about the process, so at the monthly program meetings she explained why certain people were being moved to other programs, what tasks we had left to analyze, and how the work would be divided among the people who remained in the program.

I never worried about changing people's minds who didn't understand the need for reform. I know that Judy worried about it, and others did, too, but I guess being an analytical type, I figured that if I laid out all the data for them and they still couldn't put it together, they weren't going to get it. I wanted true believers, or at least people who had enough sense to recognize that this draw-down was the best thing for the program.

After the Task Destination was completed, my engineering staff shrunk from 80 to 12.

SEVEN

Venting Space

JUDY STOKLEY
PROGRAM DIRECTOR
U.S. AIR FORCE

When people are disgruntled, they need an outlet to express their frustration. One thing that I worried about was that somebody in the program office might take that frustration to an extreme. By that I mean walk into the office with a gun and start shooting people. All you have to do is watch the evening news to realize that it would be foolish to write such things off as impossible.

In order to try to defuse tensions at our monthly meetings, I gave people note cards to write anything they wanted. At the end of the meeting, they deposited

the cards in a box. They could scream at us; they could give us recommendations—say anything they wanted. And, of course, we didn't expect anyone to sign his or her name.

Some wrote things like, "I feel betrayed." "Please don't leave me without a job, because I'm the only one working to support my family." Others wrote more mundane things: "I've asked for the Xerox machine on our floor to be fixed over and over again, and it still doesn't work reliably."

At each meeting, one of my deputies got up and explained what we had done to address concerns expressed at the last meeting. I'm proud to say that we implemented every constructive recommendation we received, including getting the damn Xerox machine fixed.

EIGHT

Change Agent

DIANE STEEG

INFRASTRUCTURE SUPPORT

U.S. AIR FORCE

I handled where people sat, what kind of desk and computer they got, what kinds of pictures went on their walls, and how quickly they got security clearances—all the things that go into making our lives in the workplace pleasant or miserable. "Infrastructure support" is what it was called, officially. To a lot of folks, my office was known simply as "stuff."

When Judy Stokley became Program Director of AMRAAM, she told me that I was going to be the foundation for the changes that we needed to make in the work place. I didn't know whether I liked that. There was a lot of hostility on the base about these changes, and I wasn't certain if I wanted to be the focus of that.

But my opinion changed in a hurry. Judy Stokley wasn't like anyone I had worked for before. For example, I had rarely associated much with heads of other offices. She encouraged me to get involved with the contracting and procurement and engineering sides of the program, to sit in on their meetings and ask questions so that I could learn; and I did. What it did was give me a much broader outlook on my role in the program, and that's when I began to feel like a leader. My role changed from, How do I support my piece of the program? to How do I support all these pieces?

NINE

My Message to You

JUDY STOKLEY
PROGRAM DIRECTOR
U.S. AIR FORCE

People often say, “If you want to create change, get rid of all the old people and bring in young ones who are fearless.” My message to you then is this: look and listen, because it may surprise you who emerges as your change agents. No one looking from the outside would have picked the people who were mine. Many of them were the kind of people who do not speak up first. Some were introverts, people with unglamorous jobs. They emerged mostly on their own, and they possessed tremendous personal courage. I simply gave them an opportunity to contribute, and they came back with some of the most creative ideas.

TEN

Walking the Talk

DIANE STEEG
INFRASTRUCTURE SUPPORT
U.S. AIR FORCE

Some of our facilities were inadequate—particularly the conference room, where a lack of space often impeded our ability to meet. To call an all-hands meeting, we had to rent a room in another building, and that could be anywhere on the base. Judy knew that we needed a new conference room, but I think that she worried about being criticized for spending the money on one. Many people believe that if you have to cut manpower to save money, you shouldn’t turn around and spend money on conference rooms and offices. That’s not “walking the talk,” as they say.

“We should have a new conference room, and I can make it happen,” I said. And I did.

I believed it was important that our team knew we were going to invest in them. Improving the facilities so that we could run a better organization was a critical step in that direction. I saw to it that we had a conference room that was a show piece for the entire base. The room holds upwards of eighty people, with state-of-the-art equipment, including a giant screen for video teleconferences. Judy wanted the room to tell the story of our program, and she wanted that done in pictures—so I commissioned a mural. It’s a room that everyone in the program can be proud of.

ELEVEN

Teammate

CHUCK ANDERSON

VICE PRESIDENT

RAYTHEON

When I first took over the job as head of the AMRAAM program at Hughes in the early 1990s, back when Judy Stokley was Deputy Program Director, we had a problem—a big problem—with the control section of the missile. It was a design issue, and it was our problem. We at Hughes needed to fix it.

It was only my second week on the job, and I was going to Eglin Air Force Base to discuss the issue. A team of government lawyers greeted me. Nice guys, no doubt, but they were there for a reason. The scene conjured up a vision in my mind of a phalanx of well-trained attack dogs.

I walked straight into the program director's office and said, "We're going to fix the missiles, and we're going to do it at our company's expense." That was a \$3-million decision. His mouth hung open in disbelief. My company wasn't obligated to do a darn thing, but that's not the way I thought we should do business. (Now, if it had been a \$50-million decision, I might not have made a decision like that.)

I made that decision because I believed my company had a responsibility to take care of our customer and live up to our agreements. Judy saw that, and when she took over as the program director, she understood that she had a teammate ready and willing to reform a troubled program.

TWELVE

Meeting of Minds

JUDY STOKLEY

PROGRAM DIRECTOR

U.S. AIR FORCE

Acquisition reform was difficult to grasp for many people involved with AMRAAM, and I struggled to sell it both to government and industry. Not long after I announced the drawdown plan in the program office, I hosted a meeting with several of the key members of the two contractors building the missile, Hughes and Raytheon. In a year, these two companies would merge, but at this meeting we were working with both their vice presidents in charge of AMRAAM, and they were sitting in the front of the room.

I wanted to talk with them about our "partnership," what was wrong with it, and what we were going to do to improve it. To make my point, I brought a copy of the "spec tree" that governed the program at the time. The document was hundreds of pages thick, and it illustrated all that was wrong with AMRAAM.

Merger and Acquisition Reform

When Raytheon sought to buy Hughes Missile Systems Company, the AMRAAM program faced a sole source contractor environment. Under business as usual, annual missile procurements would be based on certified cost and pricing data and negotiations that would allow the single prime contractor to keep a high cost base and earn weighted guidelines profits. Instead of seeing this as an annual struggle over missile unit cost, Stokley saw it as an OPPORTUNITY to control costs and enable Raytheon to plan ahead, invest, and make profits.

Source: *AMRAAM Vision 2000 Operating Guide*, Raytheon Corporation document, 2000, pp. 24–25. Copy available from NASA Headquarters, NASA Historical Reference Collection (Washington, DC), File 18292.

Over the years people had added endless low-level specs, and it was a disaster. I don't think anyone could make sense of it.

The program had been around for 20 years, and had been operational for a decade. The inventory for the Air Force, the Navy, and 12 international customers numbered some 6,000 missiles. Everyone knew what the missile did. You would think that it would be easy for people to sit down in a room and write out the performance requirements, right? Wrong.

It wasn't easy because of the type of partnership we had had. If the contractor, for any reason, needed to change something (if, for instance, a part went obsolete or he had a problem with a vendor), he had to submit an Engineering Change Proposal, and the government had to approve it. The contractor documented every change in parts, down to the lowest-level nut, bolt, or screw, and sent the change proposals all day long. The government paid him to make those changes, or they didn't get done. I used to say, "If I want my contractor to flush the toilet in Tucson, I have to write him a contract letter and pay him to do it."

I wanted very much to change that mindset, and get the contractors to have what I call a "heart and soul" relationship with their products. If we could take that unwieldy spec tree and write a good, simple set of performance specifications that the contractor would control, and on the government side we would pay him a fair price for the product, then I believed it could be a win-win situation for both sides.

Coming together in a partnership meant more than just saying, "Starting Monday, we're a team." It was figuring out how to work together in this atmosphere where we look across one another's books, we look at what we've promised to the war fighter, and we figure out how to keep everyone getting the products they need.

I also didn't want any claims against me. The program had been under litigation for one thing or another since it started. When I took over as the Program Director, there were twelve standing requests for equitable adjustment filed by the contractors. I told my counterparts on the contractor side straight out that I could not team with someone who filed claims against me. I told them: "I'm going to help you pay for everything, I'm going to help you make a decent profit, and you are going to make sure that we have a good product out there."

I laid all of this out at the meeting I held with the contractors. I explained how I thought we needed no more than a 50-page document to include all the specs, and everyone nodded their heads as though they were punch drunk. All of a sudden, Raytheon's chief engineer stood up and spoke across the room to his vice president: "Boss, I've got to make sure that before you agree to this, you understand what she's saying. Because if you do, I don't think there's any way you'll agree to it."

Everyone looked at him, and then back at me. To say that things got tense is putting it mildly. "Today," he continued, "if we change something here, the government pays; but what she's telling you is that with this deal, if we change something, we pay."

Now, I could never have scripted what happened at the meeting any better than that. It was a perfect expression of what was holding us back. This man couldn't see opportunity. He could only see risk. Why, it was so funny to me that I felt the urge to laugh, because it was indicative of the way we had managed our industry for years. These were people who were used to doing business a certain way—and change, regardless of how necessary, made them jittery. Plus, they were cynical enough about working with the government that they had a hard time believing I could be offering any kind of deal that would be good for them.

"Oh man, we don't want any part of this," said the Raytheon vice president. "This is too different." I realized I wasn't going to convince him to embrace change if he fundamentally didn't want to change. The best I could hope for was that he would go along with it until he saw that the reforms worked.

Fortunately, the Hughes vice president, Chuck Anderson, was a different story. Chuck could see the vision of what we could become. The other guy could only see the problems; he could only see where they had been, and he feared the problems that could happen if we changed. Chuck knew where we had been, and saw where we might go. I was fortunate to have someone like him on the industry side. When Raytheon and Hughes merged, Chuck stayed with the program and the Raytheon vice president left to tend other patches of status quo. The merger created lots of other issues to deal with, but the fact that we had the right person in place on the contractor's side was a tremendous help in implementing needed reforms.

THIRTEEN

The Big 'If'

CHUCK ANDERSON

VICE PRESIDENT

RAYTHEON

Judy wanted the government to save money for the program by handing over more responsibility to the contractor. If only they could trust us—that was the big “if.” Judy was willing to take that chance. She’d seen me operate, and she knew that I could be trusted.

It became obvious to me that she wanted to seize this merger between Raytheon and Hughes as a catalyst for real reform. The biggest reform of all was getting government out of the way to allow the contractor (us) to do the job of designing and building better missiles. We called this Total System Performance Responsibility, or TSPR. Officially, this meant the contractor accepted responsibility to do what is necessary and sufficient to develop, deliver, warrant, and support missiles that are affordable, combat capable, and readily available. In layman’s terms, it meant the government trusted me to decide when my product met requirements. This was unique in government contracting. In fact, it was exactly the opposite of what government employees and contractors were used to doing.

You can imagine how this sounded to me. You mean we can substitute a round capacitor for a square capacitor on a circuit board and we don’t have to ask government’s approval? As ridiculous as it may seem, changing a capacitor required a four-month approval process up to that point. We had to go through government change control boards, and I had to have a whole bureaucracy in place just for dealing with spec changes. I have a picture of myself standing alongside a 6-foot stack of paper. These were all the performance specifications.

This was a new way of doing business, and I had to sell it to my people. With this merger I would come under more scrutiny by my corporate office. All my freedom to make decisions and “do what’s right” would disappear if I didn’t make reasonable profits.

FOURTEEN

Try Telling Your Bosses

TOM GILLMAN

CONTRACTING OFFICER

RAYTHEON

Judy Stokley’s intentions were good, no doubt, but I had been burned in the past by people with good intentions. In this business, everyone has made commitments they were unable to fulfill. Good people in the government have made commitments to me as a contractor that they have been unable to fulfill. I have

The AMRAAM Partnership

The Contractor shall perform the tasks that he deems necessary and sufficient to develop, deliver, warrant, and support affordable combat capable and readily available weapons systems.

The Government shall commit to a reasonably stable production program, establish contractor control and accountability, support a long term pricing strategy, and strive to enable contractor success.

Source: *AMRAAM Vision 2000 Operating Guide*, Raytheon Corporation document, 2000, p. 7. Copy available from NASA Headquarters, NASA Historical Reference Collection (Washington, DC), File 18292.

made commitments to the government that I have been unable to fulfill. In both cases, it hasn't been for lack of trying.

Try telling your bosses, "I'm going to do several hundred million dollars worth of business on a hand shake. Don't worry, I trust my customer and they trust me—so you should trust both of us."

Contractors, as a business practice, try to avoid getting themselves in those kinds of situations. That's smart business. Most contractual relationships in this industry revolve around legalistic interpretations of big, thick documents called contracts. Whoever has the best lawyer wins, usually. I have to admit, I was skeptical that the government was capable of living up to the commitment they made.

One thing Judy did to win my trust was to eliminate the bureaucracy on their side. A large staff on the customer's side is disruptive to work. We had to be staffed in such a way as to take care of our customers, and so we had a lot of hand-holders. I used to have one person in my organization for every person that the government was going to assign to a project, plus the people to do the work. The bigger their bureaucracy, the more feeding it took. Suddenly, we didn't have to put as much into care and feeding, and that freed us up to pay more attention to building missiles. That went a long way in proving that the commitment was for real.

FIFTEEN

The Handshake

CHUCK ANDERSON

VICE PRESIDENT

RAYTHEON

After they finished their Task Destination, Judy's team came out to Tucson to work with us on our staffing. It was our turn to draw down the workforce. I had my leads attend the meeting and Judy had hers. The numbers they presented to us at first seemed awfully low, and we squabbled about it. Judy came in with around 30 people, and I said, "I don't know how I'm supposed to do the job with so few people. If you want me to try to do that I will, but it won't be what you and I want this program to be." We went through the staffing, position by position, but we still couldn't come to an agreement.

Finally, Judy and I went into my office, apart from everyone else, and she said, "Chuck, tell me what you need to do this job."

"I think I can do it with about a hundred people," I told her.

At the time we had around 400 people working on AMRAAM, so we would still need to displace a significant number of people. We shook hands on the number. When we re-joined the group, Judy announced that we would keep 100 people on the program. I remember the look in my team's eyes. It was a look that didn't mask their discomfort. They knew that many of the people who had worked on the program for years would lose their jobs, and that the rest of them would have to figure out how to get the job done with one-fourth of the former workforce. They also knew that a handshake was our only assurance that our customer was going to live up to the agreement.

"Look, we have to trust the customer on this," I said to them. "We have to trust that they understand what kind of risk we're taking in signing up for this."

SIXTEEN

The Mirror Exercise

DENNIS MALLIK

CHIEF FINANCIAL OFFICER

U.S. AIR FORCE

At our meeting with the contractor, after Chuck and Judy made their handshake agreement, we did what's called a "mirror exercise." A facilitator asked each side, government and contractor, to list what our most important issues were, and then he asked us to list what we thought the other side's most important issues were. Then we shared that information. Immediately, you could see how little we trusted each other.

The Status Quo Is No Longer Acceptable

People are encouraged to conform—to follow the rules, to document their actions, and to avoid risk, rather than innovate and use good business judgment. The system rewards those who follow the rules and avoid risk. And it allows everyone to point the finger at someone else in the process—Congress points to DoD's management, DoD points to Congress, and people within the services point to OSD leadership.

Source: "Acquisition Reform—A Mandate for Change," Policy Paper, Secretary of Defense William Perry, 9 February 1994. Accessed at http://www.cadv.org/pdf_docs/mand24.pdf on 30 September 2004.

The contractor's side thought that the government wanted a product for the lowest price, and they thought that the government team was willing to suck our company dry if that was what it took to get a low price. On the government side, some of the team thought the contractor only cared about a big profit, and didn't care about quality. One thing was clear from the process. Everyone needed to work to dispel these toxic stereotypes, or we were never going to be an effective team.

I had worked for a contractor for 12 years before I entered the government. I believed that the contractor's people would do the best job they could for us. What I didn't understand was how little they understood us.

It occurred to me that if I educated the contractor about government program planning, I might be able to help the situation. I put together a presentation for their financial managers and a few program managers, 25 people in all, and I went out to Tucson and explained how our planning and budgeting worked. Before I gave my presentation, they thought that all I had to do was ask for money today, and it would be available tomorrow. After my trip, they understood that I had a two-year delay before I could get something written into the budget.

I learned quite a bit from them on this visit. They explained that Raytheon had gone deep into debt to buy Hughes Aircraft. Around the same time, Raytheon also bought portions of Texas Instruments, and ran up more debt. Profit wasn't their main concern; it was cash flow. One of the things that we worked on was figuring out how I could improve cash flow on the program.

Following my trip to Tucson, I had better rapport with my contractor counterparts. We continued to meet face-to-face once every couple months, and we kept in close contact the rest of the time, with frequent e-mails and telephone calls.

On other Air Force projects, open communication between the government and the contractor didn't exist. When some of the people working on other programs came by to ask me for advice, they were stunned to learn how open my relationship was with Raytheon. They had been told that they couldn't ask their

contractors for information, but they saw that I didn't operate that way. I went out to Raytheon and asked for everything I thought I needed to know—and they gave it to me. “You'll be surprised by how much better you do once you get to know the people you're working with,” I explained.

SEVENTEEN

TSPR Is Not a CLIN

COL. WENDY MASSIELO

CONTRACTING OFFICER

U.S. AIR FORCE

We have a tradition in our program office that each department sponsors a fundraiser between Thanksgiving and Christmas. Our group in the contracting office was small, and we didn't have the time or manpower to organize a car wash or bake sale, or anything like that.

My best ideas always seem to come when I'm brushing my teeth or taking a shower, and I think the fundraising idea occurred to me while I was doing something like that. I went, “Oh yeah! We'll make coffee mugs that say, TSPR Is Not a CLIN.”

In the government, our traditional way of operating is to ask, “Well, what does that cost?” It doesn't matter what “that” is: a software tape, a machine part, an idea. The way we account for each of these costs on a contract is through a line item: a Contract Line Item Number (CLIN).

In trying to explain what we were doing on AMRAAM, I found I had to answer the same question all the time: how much was this Total System Performance Responsibility going to cost? Many people, both in government and at the contractor, were at a loss to understand what TSPR meant. I wanted people to stop thinking of it as a line item, as a number, and instead look at it as a philosophy. When you embrace the TSPR concept, it means so much more than the cost of delivering a missile. Cradle to grave responsibility, that's what we were trying to instill in the contractor.

The mug was a way of helping to embed this philosophy in people's minds. They would be sitting drinking their coffee, reading *TSPR Is Not a CLIN*, and I hoped that they would wonder, If it's not what it's going to cost me, then what does ‘responsibility’ mean with this missile? A motto or slogan like that makes it easy to hold onto an idea and turn it over in your head. Before long, you hear it everywhere, and you realize that it's stuck in your mind.

The timing was great. I was doing a number of briefings at the time, and at the end of each briefing I always said, “So remember now, TSPR isn't a CLIN. To help you remember that, and to help out our fundraiser, you can buy one of these mugs.” We sold a couple dozen mugs this way. Then we took them out to the contractor in Tucson, and they were a big hit there.

EIGHTEEN

Sword Bearer of Reform

JERRY WORSHAM

CHIEF OF LOGISTICS

U.S. AIR FORCE

Certain roles that were traditionally performed by the government now made sense for the contractor to do, and one of those was the repair of damaged missiles. Damaged missiles still under warranty were sent to the contractor's facility in Tucson, but those with an expired warranty went to government depots for repair.

The more depots you have, the more expenses they incur for the program, because every location has to have spare parts in inventory, plus management and maintenance facilities. It made sense that if you could combine those depots, you could streamline the operation and save money. We looked at what it would cost for the one location at Tucson to do all the depot work, and the cost savings were substantial—approximately \$10 million worth of savings in spare parts alone.

One of the Air Force depots resisted giving up their work to the contractor. As soon as I started talking about the contractor having total system responsibility for the life of the missile, they quickly saw that meant jobs flowing from a military depot to a contractor facility.

"Our manning doesn't cost you anything," argued a government representative from that depot. That threw me for a loop. "Excuse me," I said.

A lot of the manning at these depots was institutional, he reminded me. Whether there was an AMRAAM program there or another program, there would be people at these depots paid to do the work. I reminded him that without AMRAAM, he could work on other programs that had requested more support.

In addition to repairing these missiles, one of the other things we wanted to reform was the engineering support. Certain elements of the missile had a history of breaking, which compromised reliability. At one meeting, we discussed having the contractor do more of the sustainment engineering. Who better to keep the engineering up-to-date than the contractor who designed, built, and knew the missile better than anybody else? Representatives from the contractor and the depots, and even someone from Eglin, sat around the table at this meeting.

I asked the question, "Who is responsible for sustainment engineering for the AMRAAM missile?" Everybody raised a hand. "Do you see a problem here?" I asked.

In some cases, meetings with the depot representatives broke down into heated arguments. The problem was always me. I couldn't understand their point of view. They thought I was there to shut down jobs. The way I saw it, I was there to try to make the most of taxpayers' dollars.

It was a difficult task at times, but it was necessary work. Each time that I talked with someone who was stubbornly opposed to reform, I became more convinced of the need for reform. I came to see myself as one of Ms. Stokely's sword bearers of reform.

NINETEEN

What Measure Matters?

BROCK McCAMAN

PROGRAM MANAGER

RAYTHEON

Traditionally, when a missile arrived at our depot, the clock started ticking, and we had exactly 60 days to do whatever was necessary to repair the missile and make it available for shipment again.

When Judy came to us and said, “Here’s my budget,” our collective response was, “Yikes!” We realized immediately that we couldn’t keep repairing missiles the way we always had—the money wasn’t there.

So we sat down and asked, “What is the purpose of repair?” That was a no-brainer, right? It’s to get missiles to the war fighters as quickly as possible, so they can maintain their war fighting ability. Do war fighters care about “turn-around time”? Not one whit; they just want inventory, lots of missiles, so if the balloon goes up and they have to go to war, heaven forbid, they know they’re ready for action.

This is what I realized: Let me decide what I’m going to work on and how I’ll do my work, and I can provide you with more missiles per month than I can with “turn around time.”

For example, sometimes a missile is returned so broken that it isn’t worth repairing, what we call “beyond economical repair.” From a customer’s point of view, there’s no such thing as beyond economical repair. (Everything is economical if you’ve already paid the contractor to do it.) Suppose that I receive one missile that’s smashed up. After that, I receive five others that just need simple repairs. Because the clock is ticking on each unit, I have to throw all kinds of people and resources to get that first, smashed missile fixed so that we can send it out before the 60-day deadline.

Give me the flexibility to push that hanger queen aside and work on those other five missiles, and I can get them out with the same amount of energy and for the same cost as the single missile that needs more work.

We said to Judy, “Want to save money?—then let’s forget about turn-around time,” and she agreed. Now we’re measured on field availability. Because of this, we can take the contract for less money and deliver more missiles.

Here is another way we’re saving money on repairs: before TSPR, we had to tell the government about every nut, bolt, and screw we replaced on a missile, how much it cost, who worked on it, and how many hours it took to repair the unit from the day it came in until the day it went out—and we were required to file reports with all that data. We don’t keep any of that data anymore. Today, we send them a bill once a month for a fraction of the cost of what we were doing before, and we get missiles back in the field sooner. This way of contracting works better for us, for the government, for the taxpayer, and especially for the war fighter.

TWENTY

I'm Not Going to Abandon You

CHUCK ANDERSON

VICE PRESIDENT

RAYTHEON

When it came to running flight tests, Judy said to me, “Chuck, you’re going to have to contract with the test wing down in Eglin and get them to run your test for you.”

“I don’t know how to do that, Judy,” I said.

“Don’t worry, I’m not going to abandon you. I’m going to help you.”

There were 50 things like this. We were clueless at the start, but Judy Stokley is a powerful lady, and I had watched her operate for a couple of years before this. I had to believe (we all did) that when Judy made a commitment she was going to keep it.

TWENTY-ONE

On the Outside Looking in

MAJOR ANDREW C. BEAUDOIN

ENGINEER

U.S. AIR FORCE

I transferred to Eglin Air Force Base in late 1997 to join a small team in the Joint Sponsored Program Office (JSPO). Before I got there, I had heard of Judy Stokley. “She’s taken over the AMRAAM program and changed everything,” someone told me. “Very politically connected,” someone else said. “She knows what to do to get promoted.”

Those were some of the kinder things people were saying. I ran into several people who were furious with the reforms she was putting through. “She’s giving away the farm,” I heard. “She’s cutting people just to get promoted because they keep telling her to cut people, and it’s at the expense of the program, the war fighter, and the product.”

I was working on a separate program, but we fell under Judy’s purview, and so we saw her for about an hour every week. She made that time available just to stay on top of what we were doing, and it was up to us to decide what we wanted to talk to her about. She did that for all her programs. Though she didn’t demand a formal presentation, that’s what we usually put together for her.

After one of our presentations, she suggested we look at what AMRAAM was doing. She never came out and said, “You’re going to do it like this, because that’s the way AMRAAM is doing it,” but I remember her saying, “You could learn something from what the AMRAAM team is doing.”

Judy Stokley's Initial AMRAAM Reform Goals

1. Save the Government 25 percent in procurement costs.
2. Make infrastructure shifts so that at least 80 percent of procurement funds buy missiles versus other support products and services.
3. Nurture a relationship of trust and teamwork between the Government and contractor.
4. Establish a long-term program strategy to meet war fighter requirements, keep costs down, and offer a healthy business environment for the contractor (e.g., profit, award fee, and positive contractor performance assessment reports).

Source: *AMRAAM Vision 2000 Operating Guide*, Raytheon Corporation document, 2000, p. 8. Copy available from NASA Headquarters, NASA Historical Reference Collection (Washington, DC), File 18292.

Lots of people were afraid of her, including people on my own team. To put it politely, she was blunt, very blunt, in her feedback. Because I was willing to stand up and speak my mind, I took a weekly beating from her at first—until I figured out that I needed to come to the meetings better prepared. I learned that if I had something to say that made sense, and I could put together a good argument, then she listened to me. That was the way she operated.

I remember one meeting, in particular, that clarified for me what she expected of her teams. It was at a critical point when we were trying to formulate a production plan. Nobody had come up with a clear picture of appropriate criteria. The team was frustrated, and the project manager threw up his hands and said, “I’m going to tell her that we don’t know what to do.” I was the chief engineer at the time, and I told him, “I don’t think that’s the best approach with her.” He ignored my warning.

I’ll never forget what happened. She stopped the briefing and looked at all of us and said, “You want me to make this decision for you, and I know less about this program than all of you. What do I pay you people for?” I remember thinking, “I saw this coming.” She made certain that we all got the message loud and clear: We were responsible for deciding what we needed to do.

I told her later on that that was one of the best things she did for us as a team.

TWENTY-TWO

Briefing the Commander

JUDY STOKLEY

PROGRAM DIRECTOR

U.S. AIR FORCE

I got a call one day that the base commander at Eglin wanted to see me. Some of my people got wind of what was coming and told me, “Oh Judy, we heard from people in the test wing that you’re going to get killed. The base commander is furious. His people have told him that you are not funding this, that, and the other thing.”

“But I’ve been telling them this for months,” I said. Apparently no one was listening.

AMRAAM was the largest program on the base, so the reforms we were putting through would have a tremendous impact on a number of stakeholders there. The program had grown up in this environment where many parts of the base received AMRAAM money each year, and they saw that as their right. While it might have been necessary to spend our money like this during the development stage of the program, it didn’t make sense in the production phase.

In the Air Force, it’s a big deal to meet with a base commander, especially when it occurs in a public forum. By the time I arrived at his big, beautiful conference room, people were already seated all around the table. Suddenly, the commander flung open the door to his private office and strode into the conference room, red in the face and with eyes bulging. He sat down without speaking, making it clear that he felt that there was no need for him to be civil at the start since he had no intention of finishing that way.

This commander had already complained about me through his chain of command. I had heard that he went all the way to my bosses in Washington, and when he got there he was told, “We pay her to execute efficient and effective programs. We don’t pay her to shore up work forces at the product centers. Thank you very much.” After that he had to figure out how to deal with me on his own. Behind my back, he badmouthed me. In front of the audience assembled in his conference room, he tried to get under my skin, attacking me with every word out of his mouth. Through all of this I remained courteous.

I had prepared a briefing, and I answered all his caustic remarks by saying, “Noted sir, next chart,” and kept it moving. I told him, best I could, what was happening in the program. In response to the most fundamental things that I said, he would say something cynical or sarcastic, usually comments about how contractors are out there making millions off of the government and he didn’t have any use for industry.

Many people in the government, especially in the Department of Defense, have a problem with the idea that a contractor should make a profit. I always shock them when I remark, “Sure, I want him to make a profit, and I want to help

him to make it.” That is a shocker because they think they need to go to the negotiating table having gotten the contractor down so low on his cost that if he has one problem, he’s going to be in the red. To me, that’s a dumb way to do business. The worst thing in the world is to do business with a contractor in the red. He can’t get out ahead of the problems. He can’t invest in my products.

At the end of the briefing, I said, “I will proceed as planned with this program. Thank you very much for your attention today and all the time you have given me.”

I always tell people that these are very powerful things to say, “Thank you very much, I have noted all of your concerns. This is the way I am dealing with them.” You can beat down a whole lot of bureaucracy by saying that.

If you are doing something different, something that challenges the status quo, you’re going to have people who don’t agree with you and who feel threatened by you. It’s a difficult thing to sit calmly and not become argumentative when you are being attacked, but you need to do exactly that if you want to grow as a leader. Listen to the concerns expressed; then, if you still believe that you’re on the right course, you must stand firm.

TWENTY-THREE

My Schooling in Leadership

JUDY STOKLEY

PROGRAM DIRECTOR

U.S. AIR FORCE

I’ve learned more and more to trust that if I am working with the right people and I set up the right structure that they can make everything happen. When I started out in management, I tried to be in there with my team on everything. In fact, I always say, “It’s a good thing that wisdom comes with age,” because I don’t believe I could physically take the hours I used to work.

I used to work seven days a week. I remember one year when I didn’t take a weekend off for twelve months because I thought I had to do everything. I don’t do that now, and the people who work for me seem to get more done. I got to this place by learning to trust the people working with me. It wasn’t that I didn’t have the confidence in the people who worked with me before; I just didn’t know how to leave them alone.

In the early 1990s, I took a few courses at the Defense Systems Management College (DSMC). One instructor taught a course in human relationships, and it changed my life. The course was about leadership and how to communicate with the people on your team. Unfortunately, most of the other 20 or so people in the class ignored the instructor, or, worse, made fun of what she was saying. They

called it the “touchy feely” class. Understand this was 10 years ago; I think that today there would be more openness in accepting this kind of knowledge.

I loved what the instructor was saying, and absorbed it like a sponge. I had chosen a technical career and spent my adult life studying technical issues, including all my training courses after I went to work for the Air Force. I took the Myers Briggs personality test for the first time in the class. DSMC had tapes in the media library on communications and I listened to them all. I started reading all the books on leadership that I could get my hands on. I went after this with the same fervor that I had gone after advanced calculus in college.

Since 1992, I have read a roomful of books on psychology, people, and leadership; before 1992, I hadn’t read one. I said to myself, “My God, there’s a whole reservoir of knowledge out there that I didn’t know to tap.”

I always tease the people down at DSMC that they created the manager I am today. I became a different person after going there, but not for the reasons that they might think—it was not because of the specific things I learned in the management classes, but because these classes launched me on a new path to understanding the meaning of leadership.

I still see a great many people who treat leadership courses as trivial, and they spend almost no time learning how to communicate and how to motivate people. They think the best use of their time is learning how to analyze cost and schedule variances on a project. Honestly, you are going to have a zillion people who can do that. There are going to be far fewer people around to show you how to be a leader.

Reading Assignment

As she was embarking on the AMRAAM reforms, Judy Stokley assigned the book *Leading Change*, by John P. Kotter, to all the leads on the Air Force and Raytheon teams. Especially important, she thought, was the distinction Kotter made between management and leadership. “Management is a set of processes that can keep a complicated system of people and technology running smoothly Leadership defines what the future should look like, aligns people with that vision, and inspires them to make it happen despite the obstacles.”

Source: John P. Kotter, *Leading Change* (Boston: Harvard Business School Press, 1996), p. 26

TWENTY-FOUR

“That’s Confidential Data!”

CHUCK ANDERSON

VICE PRESIDENT

RAYTHEON

I decided that we were going to open our books to the Air Force, prompting a swift visit from the Raytheon corporate police. They came to my office and told me that I was breaking the rules. “That’s confidential data! You’re not allowed to show that kind of data to the government.”

I told them, “Go to hell,” literally, and then threw them out of my office.

It wasn’t the first time they had told me that I had no authority to make an agreement with a customer. They’d try to tell me, “That has to go to Lexington” (home to Raytheon’s corporate headquarters). Anything over a dollar had to go to Lexington. As such, I was on report a lot. Nothing ever came of it. After the merger between Raytheon and Hughes was finally approved by the Justice Department in January 1998, and Raytheon became the sole source provider, corporate had far bigger issues to worry about than how I was running the AMRAAM program.

At the time I entered this agreement with Judy, I still had a Hughes badge on. I actually had to get Raytheon’s chief operating officer to approve it. How did I get it done? I said we could pull it off, and I was believable. My prior track record probably had something to do with it, too. The bottom line was that I had run successful programs all of my career, and it’s hard to argue with success. Beyond all that, we definitely benefited by being in Tucson, Arizona—a long way from Lexington.

TWENTY-FIVE

Enabler

JON WESTPHAL

ENGINEER

U.S. AIR FORCE

The government is not in the manufacturing business, the contractor is. Judy Stokley and George Sudan were adamant about this. “Let them do their job. We’ll work with them to provide insight—not direction, not oversight.”

The best way to do that was to be on site, working side-by-side and supporting open communication between the contractor and the government. That was the role of an “enabler,” and that was what I did.

Initially, we tried using about 15 enablers. We paired that down to four within a short time. Enablers had to have a broad background because we dealt with contracts people, finance staff, business reps, program managers, engineers—

everyone. The four of us were not experts in any one field per say, but we knew enough across the board to communicate with people and get them in touch with other people who could help solve any problems that came up. Probably more important than anything, enablers needed to be outgoing, people who weren't intimidated by meeting new people. The contractor had to feel comfortable that we understood what he was talking about.

The first thing I did was try to convince them that even though I was from the government, I was there to help in whatever capacity I could. "Hi, I'm from the government, and I'm here to help you." Usually, that's when doors slam. But you don't convince people with just words. As they say, actions speak louder, and so we had to walk it as well as talk it.

"I'm no different than anyone else sitting around this table," I said. "This is a team effort. We've got a common goal and that's to produce missiles, so let's work together." On this particular occasion, the contractor had a technical problem with a part on the missile and needed to put a special team together of engineers and assemblers to work on it. I invited myself to join the team. The first time we met I was introduced as "John Westphal, an enabler."

Because they were contractors, they wondered how much was safe to tell this government guy and how much they should keep secret. I had to reassure them that I wouldn't discuss problems with the government unless we agreed there would be an impact to delivery. All enablers subscribed to the following unwritten rule: Whatever we talked about with the contractor remained confidential until we had identified the potential impact of a problem and created a plan to overcome it. In the case of the problem part, the contractors agreed to have me work with our Navy counterparts to find a fix. We didn't miss any deliveries, and we never had to bother Judy Stokley or George Sudan—and that was the way the two of them preferred it.

Word spread quickly at the contractor's site that I was okay. I was there to help, not to tell people what to do or to report on them. But I always approached each new situation the same way, beginning by telling them, "We are a team. Let's sit down and discuss this and see what we can do together." Once we got past their initial suspicions about me, once people started believing that, "Hey, he is really here to help," then it got easier to forge relationships because more and more people understood my role.

How do I know I was genuinely accepted? Something happened about nine months after I started going out to the contractor's site in Tucson. I wanted to talk to the Director of Operations. When I walked down to his office, there were five or six engineers standing outside, waiting in line while he had somebody in his office. I walked up to the front of the line and was going to stick my head in the office and ask a question, but the guys in line said, "Hey, what are you doing?" And I said, "Hey guys, I'm just going to ask Rick a quick question." And they said, "Hey, come on now, there's a line here." And I said, "Yeah, but I'm the customer." And they said, "You're an enabler. Get in the back of the line."

If it had been something important, something critical, I would have said, “Hey guys, you know I would, but this is really important.” And they would have said, “By all means then, go ahead and do that.” But why do that when I didn’t have to? So I waited my turn—like all the other members of the team.

TWENTY-SIX

Seeing is Believing

BROCK McCAMAN

PROGRAM MANAGER

RAYTHEON

The government thought the enablers were absolutely necessary. Their view was, “We’ve got to have somebody out there to know what’s going on, since we’re not requiring reports from you anymore.”

In the first group that came out, we had to ask for some to be reassigned because they just never got it. They couldn’t imagine they were here to help us rather than report our problems. We asked that they put themselves on a rotating basis, and they starting coming for about two weeks at a time.

What happens is, when you are a remote employee, the only way you get recognition is by communicating back to the home office. Nobody back home pays much attention to you if all you can tell them is that things are wonderful over at the contractor’s. Once we went to the two-week intervals, the value of the enablers was much greater.

It must have been about a year before I got comfortable with the notion of a government rep being an asset rather than a liability. Before TSPR, government representatives would get big points for sniffing out problems in our organization. Say something went wrong in the factory; and someone in the government noticed that we weren’t going to deliver missiles at the normal level one month. That got reported back home, and then suddenly the telephone started ringing off the hook. Instead of working in the factory to fix the problem, we were answering the phone trying to explain whether it was a problem or it wasn’t a problem.

With experiences like this fresh in my mind, I was skeptical at first about the whole idea of using the enablers. These guys had complete exposure to all our dirty laundry. And I don’t care how good you are, you still have some dirty laundry hanging around. I thought, “Great, just another bunch of government guys watching over us. Their job is going to be to pick up the phone and report every little thing.”

It turned out I was wrong, and that’s because AMRAAM became an altogether different program under Judy Stokley. Reporting problems was no longer considered good behavior, because it violated trust.

Each one had different strengths, and yet they never tried to give us contract direction. There were times during meetings when I would turn to one of them and say, “Hey, what do you think about this?” And he would come back with some real jewels.

At one point down the road, we had a program-wide discussion about whether or not to continue using the enablers. I said, “Are you kidding; they’re too valuable not to have around.”

TWENTY-SEVEN

Price-Based Acquisition

JUDY STOKLEY

PROGRAM DIRECTOR

U.S. AIR FORCE

One of the things I wanted to do was to establish a reasonable cost over a long-term pricing agreement and not force the contractor to provide cost or pricing data each year. Contractors hate this. It puts their vendors, many of whom are small businesses, in the position of having to provide certified cost or pricing data.

I believed that I had verbal approval for Price Based Acquisition (PBA) from my boss in Washington, so I pitched that to the Hughes and Raytheon before the merger as one of the benefits of reforming our old way of doing business. Then in March of 1998, a month before we were supposed to award the contract to Raytheon as the sole source provider, my boss in the Office of the Secretary of Defense told me she wouldn’t let us go forward. She wouldn’t sign the waiver. A lot of people in the political system weren’t happy about the merger, she said, and so she felt as though it was too big a risk.

I was crushed. I got the call on my cell phone as I was leaving Eglin. She went on to tell me that PBA was a “dead issue.” She said, “Don’t come to Washington to try and revisit this.” I was so upset that I had to stop driving, and I pulled off the road. That was probably as down as I have ever been about my job.

But I pulled myself together that weekend, and I called Chuck Anderson at home on Sunday. “Chuck, I can’t deliver on Price Based Acquisition,” I said. “I’m sorry, I thought I could do it, but I can’t. I can’t get approval for it.”

“Well Judy, if that’s the way it is, I guess that’s the way it is,” he said. “Let’s have a video conference on Monday, and get everybody together to figure out what to do.”

On Monday we brought the team leaders together for the video conference. I explained the situation. At first there was a lot of venting, and then Tom Gillman, the contracting officer, spoke up, and I will never forget this: “I never thought the Price Based Acquisition mattered anyway. We have to get cost data from all the same vendors on our other programs, so unless the entire department goes Price Based, it really doesn’t help us that much.”

Price-Based Acquisition

Price-Based Acquisition is a way of doing business that results in a firm fixed-price (or fixed-price with performance incentives) contract and a fair and reasonable price without the government obtaining supplier cost data. The implementation of this initiative will require changes to the requirements generation and acquisition processes to allow the use of price-based acquisition for research and development without shifting significant risk to the contractor.

Source: *Introduction to Defense Acquisition Management*, Fifth Edition, (Defense Acquisition University Press, 2001), p. 22.

I learned something extremely valuable from this: When you've got a good team, they will figure out how to overcome the little barriers that pop up along the way. I think that's one of the gifts that Chuck, Tom, and the others at Raytheon (previously Hughes) gave me. Every time we hit a barrier, Chuck Anderson and Tom Gillman were always off and running. It showed what a strong team we had built already. By the second year, any time we hit a bump, my program office at Eglin was the same way. There were no barriers anymore. They did miraculous things, things no one would have believed they could do when we first started working together. Any time we had a problem, they had it worked out before I knew it was a problem.

I still remember that Friday night after the phone call and how I felt like driving off the road. I thought so much depended on getting Price Based Acquisition. Part of the hurt was that I thought it would damage the business, but the other part was that I took it personally. I had gotten too full of myself. I was focused on putting in place all those great reforms and that great strategy, and I expected every part of the process to fall in place. I came to understand that my pride had been hurt because I had promised people something I couldn't do. I was embarrassed—but, more importantly, it was all perfectly workable.

TWENTY-EIGHT

The Words We Choose Say It All

TOM GILLMAN

CONTRACTING OFFICER

RAYTHEON

Dennis Mallik, chief financial officer on the Air Force side of the AMRAAM team, invited me to his internal budget meetings, demonstrating a level of trust that was remarkable in government-contractor relationships: trust to be able to share with your counterpart what is really going on rather than some version that's been smoothed over by your leadership; trust that your counterpart is going to listen to you thoughtfully and try to help you come up with a solution, and never use that against you.

I had been part of trusting relationships with my government counterparts before, but these were one-to-one relationships that we kept quiet, lest our leadership get wind of them and scold us for setting such a dangerous example for others. That Dennis wasn't afraid to publicly display the openness that existed between the Air Force and Raytheon was not only remarkable, it was unprecedented.

Because I wanted to honor this trust, I never used any of the data that I saw at these meetings for business purposes at Raytheon outside of the AMRAAM program. Dennis never told me I couldn't, but I understood why I was there. He regarded me as a member of "his" team as much as anybody who was in the room wearing a government badge.

He asked me only once, "Do you see anything limiting our abilities to get the job done?" After that, whenever I saw anything that could impact the AMRAAM program, it was expected that I would speak up and not wait to be asked. Dennis and the others at these meetings could use my input, or they could throw it in the trash can, but they were glad to have it anyway, and that's what was important. It was all about our abilities to get the job done. I have to emphasize that word again: our.

TWENTY-NINE

Constancy of Purpose

CHUCK ANDERSON

VICE PRESIDENT

RAYTHEON

All of my team members, approximately 80 of us, met for half a day off-site at a hotel. We did this every month. We rented a ballroom, and the whole purpose of that meeting, every month, was constancy of purpose. It was to get everybody aligned—or brainwashed, as some said.

“Let’s remember what we’re about, what our responsibility to our country is. Let’s do what’s right. What’s right is delivering on time, making sure the design is right, making sure we meet every requirement. If we do what’s right, we’ll make our financial targets. Our customer will help us in every way she can, and then by definition we’ll succeed and we’ll meet our financial targets.”

Some of the people who went to these meetings never got it, and we got rid of them. Even some of my most trusted people expressed doubts that the government, not Judy personally, could fulfill its part of this deal and get out of our way to let us build better missiles. In other parts of the organization, people make it clear that they thought we had bitten off more than we could chew.

During our open discussions, members of my team brought up examples of how the government wasn’t living up to their end of the deal. “I still have to do this.” “I’ve got to write a report for these guys.” That sort of thing.

“There are probably always going to be problems,” I said, “but we’ve got to have faith in the leadership there. They are committed to this, so let’s try to work through it.”

Ultimately, they had faith in me. I was the one whose job was on the line if we screwed up, if it didn’t work out—and I did my best to make it clear that I knew we were doing the right thing.

But you can’t do it on your own. That’s why I surrounded myself with a team of effective leaders. I’m talking about six or seven people, all hand selected by me. I knew every one of them. You need to have real leaders on your team when you’re doing something like we set out to do on AMRAAM. These were people willing to make decisions, take risks, get on with it, and not study a problem to death.

We’ve got so many smart people in this business who can’t bring themselves to make decisions because they’re afraid of failing. I selected people who could make swift decisions, if that’s what was required. And that’s what they did, proving themselves time and time again.

Leading the Change

Thanks to the ability and dedication of the thousands of acquisition professionals in the Department of Defense, and the assistance of many contractors, DOD has been able to develop and acquire the best weapons and support systems in the world. DOD and contractor personnel accomplished this feat not because of the system, but in spite of it. And they did so at a price—both in terms of the sheer expense to the Nation and eroded public confidence in the DOD acquisition system. It is a price the Nation can no longer afford to pay.

Source: “Acquisition Reform—A Mandate for Change,” Policy Paper, Secretary of Defense William Perry, 9 February 1994, p. 8. Accessed at http://www.cadv.org/pdf_docs/mand24.pdf on 30 September 2004.

THIRTY

Just Like Buying a TV

TOM GILLMAN

CONTRACTING OFFICER

RAYTHEON

When people asked me about the impact of TSPR, I used to say it was like buying a Sony TV. They say that Sony technicians never turn the televisions on when they put them together. Because of their quality control system, they know they're going to work. What the government tried to instill in us was that same kind of pride in our work.

For example, a particular piece of hardware on the missile had to work 90 percent of the time. Watching flight tests over one period, we determined that there were failures that occurred less than 1 percent of the time in over 1,000 watches. Contractually, we could have said, "Not our problem, we're not going to pay attention to it." Instead, we decided it was the right thing to do to see if we could figure out what was happening. We locked some engineers in the lab for six months and had them duplicate that failure. They determined that with a simple modification of the missile we could eliminate it.

We ended up spending a couple of million dollars to fix 5,000 missiles that weren't under warranty. We could have hidden behind the specifications. Nobody paid us to do the extra work, but it was the right thing to do for the war fighter, and that typifies what this kind of business relationship can offer. In previous contractual relationships we would have said, "Since it's not in the spec, I'm not going to do anything." We could have written a proposal to the government that said something like, "We can improve this by this much and it's going to cost this much money."

All programs have problems. In the normal mode of government contracting, everybody runs to the contract and says, "What does it say on paper?" Not us. The first thing we did was ask what was the best thing to do for the war fighter. Once we determined that, then we decided on the best way to solve the problem, given our resources.

THIRTY-ONE

Committed to a Big Vision

CHUCK ANDERSON

VICE PRESIDENT

RAYTHEON

The best thing about doing business this way was that the customer and the contractor had joint goals, joint visions. When you have that, problems become problems we solve, rather than problems we write claims for. For instance, we had

an understanding that if we disagreed about whether something was covered by warranty, Judy and I would convene to resolve it.

Take what happened when a number of missiles were damaged on an aircraft carrier. The hold of the ship had flooded with seawater. Certainly that is not a warranty issue, but we brought them all back to Tucson and refurbished them at no charge. The contract says we build a missile to work for 10 years no matter what, right? Lawyers could have a field day, but we never had a dispute. Why?

It's that big vision, and our commitment to deliver a superb weapon that our nation's war fighters can rely on. That's the common vision. Judy embraced it with all her heart, and I embraced it, too. Our jobs were to make certain that the people who worked with us shared our commitment.

CAMRAAM Program Receives DOD Life Cycle Cost Reduction Award (1998)

Deputy Undersecretary of Defense for Logistics Roger Kallock said that 57 nominations were received for the award this year that was established to recognize the success that people involved in logistics undertook to reduce life-cycle costs. One project was chosen from each of the Military Services, the defense agencies and one from industry to be the recipient of the award for their component. The deciding factors considered included returns on investment, payback time, qualitative process improvements, and joint ventures. The project receiving the highest score was awarded the overall DOD Life Cycle Cost-Reduction Award.

Air Force's Medium Range Air-to-Air Missile Vision 2000 Implementation Team: a new acquisition strategy developed by this team significantly reduced all costs in the AMRAAM program. The average unit procurement cost for the program decreased from more than \$750,000 to under \$400,000 in a contract awarded in April 1998. With its three priced options, the contract will save the Air Force and Navy \$150 million over the next four years.

Source: Press release, Department of Defense, "DOD Life Cycle Cost Reduction Award Winners Announced," 1 October 1998. Accessed at http://www.defenselink.mil/releases/1998/b10011998_bt514-98.html on 30 September 2004.

THIRTY-TWO

A Radish to Leave You with

JUDY STOKLEY

PROGRAM DIRECTOR

U.S. AIR FORCE

We have all worked for people who have been to the right schools, who were excellent speakers, who sat at the head of the table and looked prestigious and made lofty decisions, but were not leaders. I don't know how many times I have thought, "I feel so sorry for this person who is trying to lead. He can't do it."

This is an important subject for me, and not because I developed some pet interest in it while taking a management class. I want to be a leader, and I want to nurture people to come along with me as leaders, too.

It seems to me that people are leaders when they have a compelling vision that comes from their heart and soul. Leaders have a vision of how things can be, and it is integral to how they think about their world. Every now and then, we have the opportunity to work with someone like that, and we feel blessed because we know where we are headed and we know that it's a good direction, or else this person wouldn't believe in it and love it the way he or she does.

That is what leadership starts with, a vision that springs from the core of your soul like inspiration does for the great poets. The other part of leadership is being able to take that vision and implement it into action on a day-to-day basis. That's where integrity and judgment are so importantly intertwined.

Integrity is being honest and ethical, and knowing in your gut what is right. It's easy to be honest when the choices are clear. It's much harder, however, to try to figure out how to be honest in the face of ambiguity, politics, money, constituencies, and people's jobs at stake. The answers to questions are not always this or that; they may be somewhere in between.

We all have our experience, but what we need to cultivate is a reflective nature. Judgment will follow. By reflecting on experience, by learning and listening to people, somehow integrity and judgment get married.

When people first become program directors, or project managers, they are usually overwhelmed by how many things come at them on a given day—especially if they have been scientists where they had a controlled process to follow, as I did in the laboratory work that I spent so many years doing. I have learned that reflection plays an important role in management, much more important than all the physics and math that I knew.

There is a saying that I love: If you ask for directions from a man who's pulling radishes, he'll point the way with the radish. What that means is that we all have our perspectives on the way we have done things. Every person is unique, just as every program, every activity, and every group of people are unique. Be wary of adapting someone else's perspective, as if that is all it takes to be a leader. Each of us has to find what it means to lead for ourselves.

Chapter 6

SUMMARY: SENSITIVITY TO PROJECT CONTEXT



In the summary, we will briefly revisit the three objectives of this study: to provide an effective source of learning about project management, to encourage the unlearning of outdated concepts about project management, and to enhance awareness of the impact of context on projects. Whether a new concept conveyed through the cases calls for learning, (that is, adding on new concepts), or for unlearning, (that is, letting go of some old concepts), depends to a great extent on the set of beliefs that the particular reader has developed throughout his or her experience.

The cases presented in this book convincingly demonstrate numerous project management concepts. Some of them, such as planning, reviews, and communication, are well documented in the project management literature. We are therefore going to highlight in the summary three major concepts which are significantly different from the prevalent project management literature: a will to win, a results-oriented focus, and collaboration through trust. We assume that even for experienced project managers, the rich, detailed and concrete description of the application of these concepts in the four cases may constitute some learning, while for less experienced managers they may require some unlearning.

We will first discuss each of these concepts by presenting some of the instances through which they are demonstrated in the various cases. We will then show that each of these general concepts was affected by the specific project context. The concepts were therefore applied differently in each of the four cases.

A WILL TO WIN

Each case underscores a general theme of a will to win. The project leaders created environments where the status quo was challenged and measured risks were taken. “As the project manager, I ultimately made decisions about what risks to take,” said Don Margolies, ACE project manager, in *Test What You Fly?* “Several people on the project thought I was crazy. Why do it?”

The question is a good one. Aerospace technology is inherently risky, and there is a commitment to minimizing the risks as much as possible. This is accomplished through strong processes and systems, and also through leaders who are willing to challenge the status quo.

In Don's case, he made it clear that he was playing to win. He was questioned by his management team, "But how do you know the risk is low enough to put an instrument back on without retesting it under vibration?" Rising to the challenge, Don said, "I was prepared to explain."

In many cases, rising to the challenge means having faith in your decisions, even when others don't. Judy Stokley, AMRAAM Program Director, felt this kind of pressure in her story *Draw Down and Fall Out*. Of this experience she said, "It was neither pleasant nor easy . . . I had to deal with people whispering behind my back when I walked past them . . . [A]nd let me tell you, there is no pleasure in knowing that you are being blamed for other people's pain."

Jerry Worsham, AMRAAM Chief of Logistics, demonstrated a similar courageous and committed approach. In *Sword Bearer of Reform* he said, "The way I saw it, I was there to try to make the most of taxpayers' dollars." He stayed resolute. "It was a difficult task at times, but it was necessary work. Each time I talked with someone who was stubbornly opposed to reform, I became more convinced of the need for reform."

Strong project leaders let the team's will to win take over. Lynda Rutledge, Systems Engineer for JASSM, in *Straight from the Boss*, noted that Terry Little united his team under his way of thinking from day one. "A lot of bosses talk the talk about letting you take risks, but then as soon as something goes wrong, they punish you. Not Terry. He's not afraid to fail, and that's why he takes chances. 'This is a good experience for you,' he said to me. 'You're going to learn so much from this.' His sitting down with me and saying these things restored my self-confidence."

In the highly demanding and dynamic project environment, leaders encourage even their contractors to adopt a will to win by challenging the status quo. Larry Lawson, Vice President of Lockheed Martin, said in *Caution*, "Suddenly, we found ourselves in an environment where our customer was saying, 'If you want to win, you can't do things the old way.'"

A RESULTS-ORIENTED FOCUS

The best leaders spend significant time ensuring the clarity of the goal. If the goals are unclear, success is elusive. In many cases, projects have failed because of a vague understanding of the focus. In *Happy New Year, 1996*, Terry Little, JAASM Program Director, was sent to take over the JASSM project. "I showed up and told them, 'We are going to get this program on contract within six months,'" he said. The team was unsettled by his announcement, but Terry made sure they knew exactly what they were shooting for. He told them, "First you need to put aside all of your paradigms and all of your ideas about how exactly we are going to do this and start with one basic assumption: that it's going to be done in six months."

Terry gave the team a common goal, and the project became immediately more productive. Jackie Leitzel, JASSM Contracting Officer, said in *Taking Aim*, “Before Terry arrived, we were just spinning our wheels, and so I understood what he was saying about the problem of people having different goals. Before he came, Logistics might be saying one thing while Testing was saying another, and I would have to go to the program director to ask which version we were going with. And even then, I still didn’t get a clear-cut answer. With Terry we got focused fast. We had the same goal: six months to get on contract. Suddenly, we knew what we were aiming for.”

Being results-oriented may also mean not going overboard. In *Stopping at Good Enough*, Don Margolies said, “What I set out to do was to establish a mutual agreement with everyone that good enough is good enough.” Good leaders set high but realistic expectations.

Realistic expectations include deciding when the search for better solutions is worthwhile, and when it is for the good of the project to accept “good enough.” In *Keeping It Simple, Not*, Mary Chiu, ACE Program Manager for Spacecraft Development, describes an exchange between two project leaders. “This is the most simplified approach, and this will be the most straightforward system to develop and test. Is this the way you want to go?” Dr. Stone said, “Keep it simple.” In fact, that became our mantra when dealing with this issue, “keep it simple.”

To create this results-oriented focus there must develop a bias for action, even when developing project processes. Ray Morgan, Pathfinder developer, writes about how he changed the way he conducted meetings to enhance productivity in *Going for the Easy Win*. “People don’t respond to big changes overnight. If they have lived under a certain set of rules, that’s their expectation. Once I realized this, I decided to go for an easy win.” Ray employed an action-oriented style as opposed to believing that things would simply fall into place because he wanted them to.

Staying focused on results also means staying focused on the customer’s orientation. In *Know Thyself—But Don’t Forget to Learn About Your Customer, Too*, Jenny Baer-Riedhart, Pathfinder Program Manager, gave valuable insight about figuring out the needs of the individual customer. “What I failed to recognize was that people are not convinced just because the seller believes she has a wonderful product. The seller needs to understand what the buyer wants from a product.” She maintained that “[t]he most compelling sales pitch you can make is not that you have something wonderful to sell. It is, ‘I understand what you need.’” Thus, the project leader unites the team with a clear focus, a common goal, and high yet realistic expectations for the path to get them there. And all the while he keeps the needs of the customer in mind.

COLLABORATION THROUGH TRUST

The most common lesson from the four cases is probably the importance of creating an environment where people can collaborate and flourish through an open and trustful culture. In each case there is a great emphasis on developing and

maintaining trust-based teamwork. The stories elaborate the wide variety of ways that this is done.

For Jeffrey Bauer, Pathfinder Chief Engineer, in *Hula Pie and Karaoke Nights*, his team bonded through singing. “For many reasons, I could not possibly overstate the importance of these karaoke nights at Dave’s place. The whole NASA and AeroVironment team was there, along with spouses, children, and other friends that had come over for a visit. It brought the team together.”

This is why these busy project managers spend most of their time on issues of people, team building, collaboration, communication, and trust. As Jeffrey said, “Without Dave’s karaoke parties we probably still would have eventually been accepted by the community, but developing a social relationship certainly broke the ice and formed a basis of trust.”

Community acceptance cannot be underestimated, however, when speaking in terms of project success. In *Flight Party*, Ray Morgan noted, “A lot of factors contributed to our success in the skies above Kauai. One very important factor was that the people of Kauai felt invested in our success and wanted to do whatever they could to help us reach our goals.” The issue of trust extends beyond the project team itself. “Bottom line,” Ray said, “none of us can do much alone. People are the most important part of any operation, and it is only with the help of others that we do great things.”

This last point is of prime importance, since all of these projects are composed of multi-organizational, multi-discipline alliances of people and organizations. This diversity is a core characteristic of project-based work. George Sudan, AMRAAM Chief Engineer, in *Someone Has to Get It*, describes a situation (prior to the arrival of Terry Little, the new project leader) in which the various people and organizations weren’t working together. “One of the reasons the system wasn’t working was because government engineers were busy meddling with the contractor . . . ‘You can’t trust these dirty contractors. They’re all out to take advantage of you,’ they told me.”

Rather than working together, George said, “[t]hey expected us to line up with the contractor as though it was a basketball game. Here’s their Radio Frequency guy, so we’ve got to have a Radio Frequency guy. Here’s their Software guy, so we’ve got to have a Software guy. If he fakes left, you fake left. For our part on the government side, we were harassing our ‘opponents’ all the time. ‘Let me see your documents. Let me review this. Let me see how you did that.’” The people dimension is repeatedly played out through the scenes of new partners working to figure out the personalities involved.

“The best way to do that was to be on site, working side-by-side and supporting open communication between the contractor and the government,” said Jon Westphal, AMRAAM Engineer, in *Enabler*. “I’m no different than anyone else sitting around this table,’ I said, ‘This is a team effort. We’ve got a common goal and that’s to produce missiles, so let’s work together.’”

When everyone works together with a mutual sense of trust, all sides, including the customer, will benefit. Larry Lawson, Vice President of Lockheed Martin, says in *Look Who's Helping Whom?*, "My view is that the dialogue with the customer is the most valuable part of the rolling downselect process for the government and contractors." Open communication is the key. "Being willing to fix things, as opposed to arguing about them, is the kind of openness that you ultimately have to have on both sides to make it through the long haul," he said.

Through their statements and associated behaviors, successful project managers consider the people involved in a project, along with their collaboration and their trust in one another, to be the highest variables of project success. But they also need their team to have faith in them. "I need the people I depend on to support me and believe that they can trust me absolutely," said Terry Little in *Credibility*. "And I need to behave in a way that gives them no doubt, no reason to doubt that's true."

CONTEXT IS THE KEY

All four project teams studied in this research applied the three principles: "a will to win," "results-oriented focus," and "collaboration through trust." However, they applied them differently, tailoring them to the particular context surrounding their project. We will start our context analysis by showing how the four teams adapted the principle of "a will to win" to fit their unique context. In AMRAAM, this concept was the key to success. The project leader exhibited a clear and strong will to win, and thus modeled the way for the entire team. Without her clear and visible courage, and her willingness to challenge not only her subordinates and colleagues but also her superiors, this major organizational change would not even have started.

Pathfinder was also not fully supported by some of its parent organizations. The project was launched and received funding throughout its life cycle only because its project leaders developed a sense of purpose usually expected of young start ups.

JASSM was supported by its parent organizations; however, it had to cope with extremely difficult constraints and goals. In the end, the project performed better than expected, primarily as a result of its leader's willingness to challenge almost any existing process.

ACE was surrounded by a very diverse and complex organizational environment. First, projects in NASA are traditionally organized by a matrix structure, while in the USAF they are typically organized by the project structure. (This structure is more or less independent from the rest of the organization, and is one in which the project leader is granted greater authority than in the typical matrix structure). Second, ACE operated under a novel arrangement of a co-leadership between a project manager and a principal investigator. Understandably in such a complex environment, the will to win was not exercised frequently. However, when it was deemed by project leaders or team members that there was a need to challenge the status quo, this principle was applied very swiftly and without hesitation.

To be successful in such a complex environment, ACE systematically employed the second principle, a “results oriented focus.” In particular, they identified the areas where the search for optimal solutions was worthwhile, while for the rest of the project, they readily embraced solutions that were “good enough.” This approach was probably the hallmark of their performance. Also, the most important reviews they held were action-oriented, or as they termed them, “implementation reviews.”

In JASSM, a results orientation was paramount at all stages. First, the project overcame its first challenge by converging on one goal only, a very clear and visible timetable goal. The project then made numerous uses of short term results (prototyping). Throughout, an action-oriented mode of operation was adopted by all team members.

In Pathfinder, the primary focus of the project was on testing and refining a new technology. Therefore, experimentation and action were the most important aspects. Yet they were successful, probably due to their ability to also focus on work processes. AMRAAM, on the other hand, was able to achieve remarkable results in a short period, due to the team’s ability to find the right balance between pursuing idealist objectives and pragmatic practices.

The concept of “collaboration through trust” was also applied differently by the four projects. In Pathfinder, a small group of people were co-located away from their permanent base and were able to naturally form an extremely cohesive, powerful—and remarkably badgeless—trust-based team. In AMRAAM, two very large organizations in a crisis situation took explicit measures to develop and sustain a large, long-term, trust-based team committed to a clear purpose. In JASSM, three large organizations under acute time pressure took several explicit steps to ensure success. One of them was the development of small, time-bound, co-located, and trust-based teams. In ACE, three large organizations which were widely diverse (both geographically and culturally) were faced with the development of a complex product within a fixed timetable as well as other unique constraints. Without reducing the cultural differences, trust-based cooperation did not culminate in the development of one cohesive team. Rather, various groups and individuals developed different mechanisms with varying degrees of cooperation. This cooperation depended primarily upon the constraints imposed by the “cultural distance” between the organizations.

Following this context analysis, the discrepancy discussed elaborately in the introduction is reinforced. The “one best way” approach is still the prevailing paradigm in project management literature. Yet by tailoring their management approach to the constraints and opportunities provided by their unique project context, our four remarkable project leaders and their teams were able to clearly demonstrate that “context is the key.”

The new paradigm should therefore be:

Even though general project management principles exist, their successful application depends on the specifics of the situation.

Exposing practitioners to a greater variety of experiences may facilitate the required paradigm shift. We hope, therefore, that the variety of stories within each case, and the variety of the story-based cases in the book, will help facilitate the required paradigm shift.

EPILOGUE: WHAT HISTORY AND HISTORIANS CAN OFFER PROJECT MANAGERS



This book is a step in a new direction for the NASA History Division. While a subseries of the NASA History Series is devoted to management histories (SP-4100), these volumes have been somewhat scattered. This book represents the start of what we hope will be a cooperative effort between our office and the NASA Academy for Program and Project Leadership.

This book is also a new venture for us in its groundbreaking, some might say unusual, use of storytelling. Most historians are familiar with the techniques of oral history interviewing, but this “storytelling” approach is rather different. In this book, the three authors interviewed key managers of four projects about how they dealt with the specific challenges of running aerospace programs with budget, time, and quality pressures. Todd, Alex, and Ed recorded these interviews, had them transcribed, and then worked with the managers to ensure accuracy. They interspersed various pieces of these interviews so that the overall narrative flowed like a group discussion.

When I first read a draft version of these chapters, I was pleasantly surprised by how much information was conveyed in a rather colloquial tone. I hope you will agree that the book is an “easy read” and accessible even to those with very short attention spans. The storytelling approach is not burdened with the academic jargon that many readers have unfortunately come to associate with history. The book has gone through our usual peer review process (and stood up to an extra level of scrutiny given its unusual approach) to ensure that the content passes a “reality check” and contains not just description, but also significant and new historical analysis.

Toward this end, we have retained footnotes to provide documentation where appropriate. There is also a list of all the interviews conducted for this book, and researchers may gain access to the full written transcripts through our Historical Reference Collection of archival materials at NASA Headquarters. While historians are typically most comfortable referring to the written word and primary source documents, there is obviously much to learn from verbal formats. Oral history interviews are meant

to fill gaps in the documentary record. The authors' storytelling approach goes beyond oral history, however, in combining the advantages of casual, insightful conversation with the rigor of the printed word. Thus we hope to have combined the best of two worlds: the straightforward writing in story format of the project management community and the hard-hitting analysis of the historical community.

In fact, the more I thought about this project initially, the better the storytelling approach seemed to fit. At its root, storytelling is indeed a significant part of history. I remember when I was having trouble writing a paper on a particular history of science topic and had to ask for help from a colleague. Over the phone, I described the topic that I was trying to cover, and explained my frustration at not knowing how to organize the material in a sensible way. My colleague simply urged me to "tell the story." At the time, however, I wasn't really sure what my story was or should be. By pushing me to think this through, my colleague was actually pushing me to move beyond narrating the basic factual details of my story and explain to him or others why my story mattered at all. In gleaning the most salient nuggets from many hours of discussions, the authors have done the historian's job of telling us why these four stories matter.

History professors often challenge their students to answer the infamous, "So what?" question by explaining why anyone should care about their chosen topic of research. This book cuts to the heart of why management is important: it's all about the people. In technical fields such as aviation and space, there's often a misguided temptation to get overly focused on the technologies themselves. This can lead to "buff" history in which the technologies are glorified without any analysis. Yet as James Webb, NASA's Administrator during most of the 1960s, liked to remind people, NASA's real challenge is managing people, not hardware. In fact, management techniques themselves may be more important tools than any engineering hardware.¹ While the physical tools of engineering indeed change over time, good management itself (some might say leadership too) is one tool that will never go out of style. Thus, in order to do a better job now and in the future, it should be especially relevant and worthwhile for readers to learn how some top-notch aerospace managers have practiced their craft in the past.

There are a number of ways in which project managers can benefit from working with historians. Most people think about past events and practices when making daily decisions without consciously using history. Historians can help managers by making these thought processes more explicit. All of us use implicit knowledge of the past to some extent, but thinking about specific historical similarities and differences can help us draw relevant analogies and reject invalid assumptions. Historical data can improve decision-making when appropriate analogies are drawn.

Historians can also provide useful contexts for evaluating management situations. Again, one needs to ask whether something similar has happened before, or whether there is something significantly new about a particular problem. Having a broad base of knowledge on which to draw helps us see patterns, rather than just the individual leaves of many trees in a forest.

Finally, we can learn from both our successes and failures. Historians are trained to parse out the many factors that contribute to a project's outcome. Historians can analytically separate the wheat from the chaff and critically challenge our assumptions about why something occurred the way it did. NASA has certainly had its share of high-profile disasters, as well as stunning achievements, but neither the accomplishments nor the tragedies were dictated by fate. It may be more comfortable to think that our accomplishments are due solely to hard work and our failures to bad luck, but each of these assumptions is equally misguided.² Nevertheless, we certainly should not shy away from tackling difficult or uncomfortable topics. Truly understanding what went wrong in the STS-107 accident, for example, is the only way that we can hope to prevent future accidents in the Space Shuttle program. Indeed, philosopher George Santayana's maxim that those who forget the past are doomed to repeat it certainly holds true.

This ability of good historians to parse out the most decisive factors behind a particular event or situation can be helpful in terms of imagining alternative historical scenarios. While the recent trend of so-called counterfactual history may seem to lack practical application, it can help us better understand the past.³ In a related vein, creating "near" and "hypothetical" histories can help us make sense of relatively rare events by thinking about what factors would need to differ for the historical outcome to have differed.⁴ Similarly, some political scientists create "lenses" or paradigmatic models to analyze a single historical episode in markedly different ways.⁵ By imagining such hypothetical situations, historians are analyzing what factors are critical to a particular historical story, thus identifying root causes and effects.

While analytical historical thinking is hard work, devoting even short periods of time to it can be quite rewarding. While historical research can usually help inform one's perspective, it is typically not necessary to read multiple volumes or to be a recognized expert on a particular subject to benefit from considering just how past events may be similar or different from current situations. Even busy decision-makers can benefit from thinking briefly in explicitly historical ways.⁶

In addition to adopting more accessible methods of communicating valuable information such as the authors' storytelling approach, I think there are numerous ways that historians can benefit from working with project managers. Hopefully this book will be a starting point for this type of cooperation and learning.

STEPHEN J. GARBER
NASA HISTORY DIVISION

NOTES

- 1 Stephen B. Johnson's aptly titled book *The Secret of Apollo: Systems Management in American and European Space Programs* (Baltimore: Johns Hopkins University Press, New Series in NASA History, 2002) is an exemplary historical treatment of how important management can be in the aerospace context.
- 2 One of the themes of Asif Siddiqi's *Challenge to Apollo: The Soviet Union and the Space Race, 1945-1974* (NASA SP-2000-4408), a sweeping treatment of the Soviet space program, is that we should not presume that because the Soviets effectively lost the space race of the 1960s that this was preordained by inferior hardware or management techniques. While the Soviets' approach to human space exploration has been very different from the U.S. approach, each program has had its share of triumphs and failures.
- 3 Practitioners of counterfactual history spin out specific "what if" scenarios. For example, would NASA have put Apollo astronauts on the Moon in the 1960s if President Kennedy had not been assassinated in 1963? See, for example, John M. Logsdon's chapter "What If? Paths Not Taken" in *Looking Backward, Looking Forward: Forty Years of U.S. Human Spaceflight Symposium* (NASA SP-2002-4107), edited by Stephen J. Garber.
- 4 James G. March, Lee S. Sproull, and Michal Tamuz, "Learning from Samples of One or Fewer," *Organization Science*, vol. 2, no. 1 (February 1991), p. 8
- 5 Graham Allison and Phillip Zelikow's *Essence of Decision: Explaining the Cuban Missile Crisis* (New York: Addison Wesley Longman, 1999) is a classic that explores the Cuban Missile Crisis from several different independent perspectives.
- 6 Much of this discussion about how history can inform good policymaking is derived from Richard E. Neustadt and Ernest R. May, *Thinking in Time: The Uses of History for Decision Makers* (New York Macmillan Free Press, 1986). This excellent book inspired a Web site called Thinking About NASA History that describes what historians of science and technology do and how they do it. This material is available online at <http://history.nasa.gov/thinking/index.html>

APPENDIX A: LIST OF INTERVIEWEES



Below is the detailed list of interviews by project, participant(s), date, location, and duration.

ACE

- Donald Margolies, Frank Snow, and John Thurber; 25 July 2001; Goddard, MD; 6 hours
- Donald Margolies; 27 July 2001; EduTech, Silver Spring, MD; 3 hours
- Allan Frandsen; 5 November 2001; Pasadena, CA; 4 hours
- Mary Chiu, Donald Margolies; 12 November 2001; Goddard, MD; 4 hours
- Mary Chiu; 26 December, 2001; APL, MD; 1 hour
- Conference call with Mary Chiu; 4 January 2002; 1 hour
- Donald Margolies; 7 March 2002; Goddard, MD; 2 hours
- Conference call with Frank Snow; 8 March 2002; 1 hour
- Conference call with Judy von Mehlem; June 24, 2002; 1 hour
- John Thurber; 27 June 2002; Goddard, MD; 1 hour
- Dr. Edward Stone; 17 July 2002; Caltech, CA; 2 hours
- Conference call with Allan Frandsen, Donald Margolies; 31 July 2002; 1 hour
- Donald Margolies in his home; 22 August 2002; MD; 4 hours
- Conference call with Gerry Murphy; 15 October 2002; 2 hours
- Donald Margolies; 19 August 2003; Annapolis, MD; 15 minutes

Total interview time: 33 hours

JASSM

- Terry Little; 19 August 2001; Tysons Corner, VA (2001 Masters Forum); 6 hours
- Lynda Rutledge, Brian Rutledge; 22 August 2002; Terry Little's office, VA; 6 hours
- Larry Lawson; 6 December 2002; Lockheed Martin in Rockville, MD; 2 hours
- Jackie Lietzel; 14 January 2002; Rosslyn, VA; 2 hours

Total interview time: 16 hours

Shared Voyage: Learning and Unlearning from Remarkable Projects

PATHFINDER

Jenny Baer-Riedhart (via telecom), Jeffrey Bauer, Dougal MacLise, Ray Morgan; 15 March 2001; Pasadena, CA (Knowledge Sharing East-West Conference) 3 hours

Jenny Baer-Riedhart, Jeffrey Bauer, Ray Morgan; 9 May 2001; Dryden Flight Research Center, CA; 8 hours

Jenny Baer-Riedhart, Jeffrey Bauer, Dougal MacLise, Ray Morgan; 22 August 2001; Tysons Corner, VA (Masters Forum) 4 hours

John Del Frate, Ray Morgan; 11 February 2002; Dallas, TX (Masters Forum) 2 hours

Ray Morgan; 12 February 2002; Dallas, TX (Masters Forum) 4 hours

Ray Morgan, John Del Frate; 13 February 2002; Dallas-Fort Worth Airport (after Masters Forum); 2 hours

Total interview time: 23 hours

AMRAAM

Maj. Andrew Beaudoin, Dennis Mallik, Dianne Steeg, Judy Stokley; 6 May 2002; Judy Stokley's office, Rosslyn, VA; 7 hours

Tom Gillman, Brock McCaman; 30 May 2002; Raytheon, Tucson, AZ; 6 hours

Col. Wendy Massiello, George Sudan, Jon Westphal; 4 June 2002; Eglin Air Force Base, FL; 6 hours

Conference call with Jerry Worsham; 28 June 2002; 1 hour

Conference call Chuck Anderson; 5 March 2003; 1 hour

Total interview time: 21 hours

APPENDIX B: BIOGRAPHIES



ADVANCED COMPOSITION EXPLORER (ACE)

Donald Margolies was project manager of the Advanced Composition Explorer (ACE) mission. ACE, launched in August 1997, has been providing scientists with information about space matter and near-real-time advance warning of geomagnetic storms. ACE is one of several missions run in the NASA Explorer Program, which is characterized by relatively low- to moderate-cost and small- to medium-sized satellites capable of being built, tested, and launched in a short time. Mr. Margolies received the NASA Medal for Outstanding Leadership for his work on ACE, and has also received the NASA Exceptional Service Medal. He retired from NASA in January 2004 after 41 years at the Goddard Space Flight Center in Greenbelt, Maryland.

Dr. Edward C. Stone was director of the Jet Propulsion Laboratory in Pasadena, California while also serving as the Principal Investigator on ACE. As JPL director from 1991 to 2001, Dr. Stone led the laboratory during a decade in which it took on the management of dozens of planetary, Earth sciences, and astrophysics missions. Since 1972, he has served as the project scientist for the Voyager Mission. Following the 1977 launch of the twin Voyager spacecraft, he coordinated the efforts of 11 teams of scientists in their studies of Jupiter, Saturn, Uranus and Neptune. Dr. Stone has received many distinguished awards, including the NASA Outstanding Leadership Medal (in 1986 and 1996).

Allan Frandsen was Science Payload Manager for the Advanced Composition Explorer (ACE) mission, working out of Caltech in Pasadena, California. Mr. Frandsen retired from NASA after a 36-year career, which was mostly spent at the Jet Propulsion Laboratory (JPL) in Pasadena working on space science programs. During the 1980s, he spent four years at the Office of Space Science at NASA Headquarters where he managed a number of successful programs.

Mary Chiu was program manager for the ACE spacecraft at the Johns Hopkins University Applied Physics Laboratory (APL) in Columbia, Maryland, where she worked from 1985–2003. Before her retirement, she managed a variety of programs including the APL UltraStable Oscillator programs for the Navy (NRL) and NASA (Mars, Observer, EUVE, Cassini), Altimeters for the Navy (SPINSAT), and NASA spacecraft (ACE, CONTOUR). Her last assignment was program manager for spacecraft development on NASA's CONTOUR mission, which was part of NASA's Discovery Program.

Frank Snow has been a member of the NASA Explorer Program at Goddard Space Flight Center since 1992. He was the Ground Project Manger for the Advanced Composition Explorer (ACE), which launched in August, 1997, and the NASA project manager for two small explorer (SMEX's) projects from 1997 to 2003. Frank is presently the NASA project manager for the Time History of Events and Macroscopic Interactions During Substorms (THEMIS). THEMIS, a constellation of five satellites observing the auroral borealis, will be launched in October 2006. Frank began his career with NASA in 1980.

John Thurber was NASA's observatory manager on ACE, working out of Goddard Space Flight Center. He was the NASA interface between the Goddard project management team and the spacecraft developers at APL. Most recently, he served as instrument manager on NASA's Solar-Terrestrial Relations Observatory project.

Gerald Murphy led the systems engineering effort for payloads on ACE. In 1996 he left the Jet Propulsion Laboratory (JPL) to launch Design Net Engineering, an aerospace hardware/software development company located in Denver, Colorado. Mr. Murphy began his career in the "space business" at the University of Iowa under James Van Allen, where he worked many explorer missions and earned separate masters degrees in Astrophysics and Electrical Engineering. After a period in the early 1980s working shuttle payloads, he began work at JPL where he was involved in radiation effects on electronics, electromagnetic compatibility, and advanced sensor development. His years of experience were critical to the success of the diverse cross-section of scientific instruments used on ACE.

Judi von Mehlem led the systems engineering effort for spacecraft development on ACE. In her more than 20 years with JHU/APL, she has been system engineer or RF engineer on a number of missions and proposals. These included programs such as the TOPEX altimeter and the Aladdin proposal to the NASA Discovery Missions. Presently she is the RF lead engineer for the two STEREO spacecraft. While at Computer Science Corporation, she supported DCA in their preparations to the 1979 World Administrative Radio Conference. Prior to this she was with the Government of Canada, where she was active in HF propaga-

tion predictions for the Canadian environment and served as Canadian Chairman of the CCIR Study Group for ionospheric propagation and as a member of the Canadian delegation at the ITU technical meetings in Geneva.

JOINT AIR-TO-SURFACE STANDOFF MISSILE (JASSM)

Terry Little was the Air Force program director for the Joint Air-to-Surface Standoff Missile (JASSM) program from 1996 through 2001. With more than 20 years experience as a director on major weapons programs, Little is considered one of the best, as well as one of the most maverick. Throughout much of his career, he has been known as a forceful advocate for acquisition reform, and always in the vanguard when it comes to implementing reforms. He entered the Air Force in 1967 and served on active duty until 1975. As a civilian employee he has been operations research analyst, a program director for a classified program, a deputy program director for both a large, multiple-program office and a Navy-led joint program office and a weapons development planning manager. In 1997, he was promoted to the Senior Executive Service. He is presently director of the Kinetic Energy Boost Office at the Missile Defense Agency.

Larry Lawson was Lockheed Martin's Vice President of Strike Weapons while on the JASSM program. In that position he was responsible for domestic and international weapons programs, maintaining a portfolio of systems that included the JASSM program. He also served on the Board of Directors of PGSUS, an International Joint Venture with the RAFAEL Corporation. Currently Mr. Lawson is Vice President of Systems Integration and Business Development for Lockheed Martin in Bethesda, Maryland. Mr. Lawson has received Inventor- and Manager-of-the-Year awards from Lockheed Martin and holds patents in Advanced Discrimination Technology. Programs he has managed have been recognized for their excellence by the Air Force and the Office of the Secretary of Defense.

Brian Rutledge was the Air Force program manager for the Boeing contract during the source selection phase of the JASSM program between 1996 and 1998 during the Production Development and Risk Reduction (PDRR) phase to downselect to one contractor. Mr. Rutledge entered government service in 1984 after eight years in private industry. He has served in multiple system program office assignments during his 18-year Air Force career, while becoming a recognized leader in the research, development, testing and evaluation of air armaments. Mr. Rutledge is presently the director for the Joint Direct Attack Munition (JDAM) program office at Eglin Air Force Base, Florida.

Lynda Rutledge was an Air Force systems engineer on the JASSM program during the source selection phase. After leaving the JASSM program, she managed the concept exploration and planning of what is now the Small Diameter Bomb (SDB) program. She started the SDB acquisition program and served as program manager for the SDB program within the Lethal Strike Program office at Eglin Air Force Base until March 2002. Ms. Rutledge began her Air Force career in 1989 as a mathematician in the Freeman Mathematical Laboratory. She is currently deputy director in the Precision Strike System program office within the Armament product group at Eglin Air Force Base, Florida.

Jackie Leitzel was the Air Force Chief of Contracting on the JASSM program. She is presently the Director of Contracts for the Air Force Office of Scientific Research.

THE PATHFINDER SOLAR-POWERED AIRPLANE

W. Ray Morgan led the development of the Pathfinder solar-powered airplane for AeroVironment, Inc., where he founded its Design Development Center and was its director for 20 years. All eight solar aircraft altitude records recognized by the National Aeronautics Association through 1998 were held by teams he managed. Mr. Morgan received the Aviation Week Laurel Award in 1995, and in 1997 received the NASA Public Service Award and was inducted into the Aviation Week Hall of Fame. Mr. Morgan retired as a vice president at AeroVironment in 2000. He presently serves as a senior technical advisor to NASA, as well as a consultant for high-tech companies in the fields of management system optimization, project management, and aircraft design and testing.

Jenny Baer-Riedhart was program manager for the Environmental Research and Sensor Technology (ERAST) Program in charge of technology flight testing for Unpiloted Aerial Vehicles, including the solar-powered Pathfinder. She started her career at the NASA Dryden Flight Research Center in Edwards, California in propulsion engineering, working on the first computer-controlled jet engine on the F-111 project. Since then she has worked on a number of flight test projects. She is presently the deputy for the Public Affairs, Commercialization and Education (PACE) Office at Dryden.

Dr. Robert E. Whitehead was appointed NASA's Associate Administrator for Aeronautics in 1995 and Associate Administrator for Aeronautics and Space Transportation Technology in 1997. As an Associate Administrator, Dr. Whitehead led a Research and Technology Enterprise of over 6,000 civil servants and a similar number of contractors at four research centers with an annual budget of approximately \$1.5 billion. Dr. Whitehead was awarded NASA's Distinguished

Service Medal and the Presidential Meritorious and Distinguished Executive Awards. He holds the rank of Fellow in the American Institute of Aeronautics and Astronautics. Dr. Whitehead retired from Federal service in December 1997.

Dougal Maclise was the project manager for the Airborne Real-Time Imaging System (ARTIS) payload on the solar-powered Pathfinder. ARTIS was used on Pathfinder to conduct remote sensing missions over the island of Kauai at altitudes above 41,000 feet. Mr. Maclise has been a member of the management team for NASA on several projects at the Ames Research Center in Moffett Field, California. He is currently one of the systems engineers for the Integrated Vehicle Health Management (IVHM) Project at Ames. Before joining the IVHM team, he served as Engineering Manager for the Vertical Motion Simulator Modernization project.

Jeffrey Bauer served as the chief engineer and deputy project manager on the ERAST program. Mr. Bauer also led a team to explore concepts for the commercialization of the Helios (the next-generation solar-powered aircraft following Pathfinder) technology that would allow NASA to share in the commercial success of this technology.

John Del Frate joined the ERAST program in 1994 as a deputy project manager. Since 1996, he has served as the ERAST project manager for NASA, during which time he has been involved the Pathfinder Plus; the Theseus, a prototype of the Solar-Powered Formation Flight aircraft; and the Helios Prototype (formerly named Centurion) which set a high altitude record of 96,863 feet over the island of Kauai.

ADVANCED MEDIUM RANGE AIR-TO-AIR MISSILE (AMRAAM)

Judy Stokley served as program director of the Air-to-Air Joint System Project Office (JSPO) at Eglin Air Force Base in Florida from 1997 through 2001. The JSPO included the Advanced Medium Range Air-to-Air Missile (AMRAAM) program. Ms. Stokley has earned many awards for her performance in reforming the AMRAAM program, including the Aeronautical Systems Center Contributing Civilian of the Year ; the Air Force Productivity Award for Professional Excellence; the Air Force Chief of Staff Team Excellence Award; the Department of Defense Life-Cycle Cost Reduction Award; the Secretary of the Air Force Office of Acquisition Award for Customer Support; the Defense Acquisition Executive Certificate of Achievement; and the Secretary of the Air Force Office of Acquisition Lightning Bolt Award. Ms. Stokley began her Air Force career in 1979 as a mathematician in the Armament Laboratory, and subsequently, worked in development planning and system program offices. A member of the Senior Executive Service, she is presently the Air Force Program Executive Officer for Weapons.

Charles (Chuck) Anderson was vice president of the air-to-air missiles product line at Raytheon Missile Systems in Tucson, Arizona, and was responsible for all Advanced Medium Range Air-to-Air Missile (AMRAAM), AIM-9 Sidewinder, and Advanced Short-Range Air-to-Air Missile (ASRAAM) efforts, including development, testing, and production. Prior to his current position, Chuck served as Tucson's director of quality and material. Chuck also served as the vice president and program director of the Convair Division's Advanced Cruise Missile (ACM) program—a position he held from 1991 through 1993. In 1989, Chuck was named vice president and program director of the Phalanx gun system at the Air Defense Systems Division of General Dynamics Corporation in Pomona, Calif.

Thomas Gillman is a manager of contracts for Raytheon's air-to-air missile programs. Chief among these programs is the AMRAAM missile. The AMRAAM program enjoys a unique culture in which the DOD and Raytheon are teamed to achieve program objectives, and Mr. Gillman has played a key role in that culture and has supported the DOD with Raytheon (formerly Hughes Aircraft) since 1981.

Brock McCaman was the program manager on Raytheon's AMRAAM contract with the Air Force during the period of reform implemented by Judy Stokley and Chuck Anderson.

George Sudan was the chief engineer for the U.S. Air Force on the AMRAAM contract and one of the earliest proponents of acquisition reform in the AMRAAM program office.

Dennis Mallik was the chief financial officer for the Air-to-Air Joint Systems Program Office. In this position, he directed financial management activities for AMRAAM. He was influential in adapting Vision 2000 to the financial area and establishing a partnership with industry. Mr. Malik retired from civil service in December, 2002. He now works as a senior cost research analyst for Jacobs Sverdrup

Colonel Wendy Masiello served as the chief of the contracting division on AMRAAM from 1997 through 1998. Her awards include the Defense Meritorious Service Medal, the Meritorious Service Medal, and the Air Force Commendation Medal. Colonel Masiello is presently the commander of the 95th Air Base Wing at Edwards Air Force Base in California.

Jon Westphal worked all aspects of manufacturing/production as an enabler for the Joint Systems Program Office on the AMRAAM program. He began "enabling" in August, 1998, and performed all concurrent engineering functions to ensure system producibility was met without sacrificing system performance. He currently works for Jacobs Engineering, Sverdrup Technologies.

Dianne Steeg was the chief of information technology operations for the AMRAAM program while working for Judy Stokley, and her job presently under a different program director is the same. She has been with the Joint Systems Program Office since February, 1994, and has worked for the Air Force since 1974.

Jerry Worsham was the chief of logistics at the Air-to-Air Joint Systems Program Office at Eglin Air Force Base. He oversaw the logistics support planning and followed the progress of problem resolutions from the perspective of the program office. He retired from the Air Force in July 2000 after a 30-year career, during which he was named the Logistics Manager of the Year by three different commands. He currently works for the Raytheon Corporation.

Major Andrew Beaudoin was stationed at Eglin Air Force Base, where he served as chief engineer and program manager for the HARM Targeting System (HTS) program. He presently serves as an Action Officer for the Air Force Program Executive Officer (PEO) for Weapons.

AUTHOR PROFILES

Dr. Alexander Laufer

Dr. Laufer is the editor-in-chief of the NASA Academy of Program and Project Leadership magazine, ASK—Academy Sharing Knowledge. He is a member of the editorial review board of the Project Management Journal, and served as a member of the advisory board of the NASA Academy of Program and Project Leadership.

He received a Bachelors of Science in Civil Engineering from the Technion-Israel Institute of Technology in 1971, and a Masters of Science in Construction Management in 1976. He was awarded a Ph.D. in Civil Engineering at the University of Texas at Austin in 1980.

During the last 20 years, Dr. Laufer has conducted research and taught at five U.S. universities. Currently he is a professor and the dean of the Faculty of Civil and Environmental Engineering at the Technion-Israel Institute of Technology, as well as a visiting scholar at the Department of Civil Engineering at the University of Maryland at College Park. He is a recipient of a Fulbright grant and several lectureship awards.

He has taught and given seminars to executives and project managers at various organizations such as: AT&T, Bechtel, DuPont, Exxon, General Motors, IBM, Lockheed Martin, Mobile, Motorola, NASA, Proctor & Gamble, Stone and Webster, Texaco, the Department of Defense, and the U.S. Department of Commerce.

Dr. Laufer is the co-author of *Project Management Success Stories: Lessons of Project Leaders*, (Wiley, 2000), the author of *Simultaneous Management: Managing Projects in a Dynamic Environment*, (American Management Association, 1997), and the co-author of *In Quest of Project Excellence through Stories*, (Procter & Gamble, 1994).

Todd Post

Mr. Post has been writing professionally for close to 20 years. He has published in newspapers, magazines, professional journals, and in a variety of electronic media. The subjects he has written about are as eclectic as the places he has published.

From 2001 to 2003, he was editor of ASK Magazine, during which he raised the magazine from an electronic newsletter with a few hundred readers to a four-color print publication with 5,000 subscribers to the print edition and 8,000 subscribers to the electronic edition. ASK Magazine won numerous prizes for publication excellence, including two Blue Pencil Awards from the National Association of Government Communicators, the most distinguished award given to a government publication.

Mr. Post published several articles about ASK Magazine, and was frequently invited to speak in public about the magazine and the use of storytelling to capture and disseminate the knowledge of NASA project managers.

Mr. Post has a Master of Fine Arts in Creative Writing from George Mason University. He has also taught writing at a number of universities, including George Mason, Penn State, and the University of Maryland.

Dr. Edward J. Hoffman

Dr. Hoffman is the director of the NASA Academy of Program and Project Leadership. In this capacity for the last 12 years, he has been responsible for the development of program and project leaders and teams within NASA. This includes the development and maintenance of a comprehensive program and project management competency model, training curriculum, consulting services for project management teams and knowledge sharing strategies. Dr. Hoffman works both within NASA and externally with leaders of industry, academic institutions, associations, and other government agencies to establish priorities and enhance capabilities in program and project management.

Dr. Hoffman is the co-author of *Project Management Success Stories: Lessons of Project Leaders*, (Wiley, 2000), and the co-author of *Where Do You Go After You've Been To The Moon* (Krieger, 1997). He is a frequent invited speaker at conferences and associations and has authored numerous articles.

Dr. Hoffman has designed workshops on leadership, creativity, high-performance teams and organizational behavior. He has taught at Webster University, George Mason University, and the University of Technology at Sydney.

Dr. Hoffman holds a Doctorate as well as a Master of Arts and Master of Science degree from Columbia University in Social and Organizational Psychology. He received a bachelor of science in psychology from Brooklyn College in 1981.