

Doing Things Right in Space Programs

This article is part of a series started in January, 2000. My intent is to share a philosophy and ideas for how to increase the chances of success in space missions while also reducing total cost. Once these articles are completed, I plan to assemble them into a book. Please send comments to me at Tom.Sarafin@instarengineering.com.

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Ten Principles for Doing Things Right in Space Programs

1. **Adopt the right attitude**
2. **Invest in knowledge and understanding**
3. **Instill ownership and responsibility**
4. **Constantly seek ways to improve teamwork**
5. **Follow a sound engineering approach**
6. **Reduce total cost through good engineering**
7. **Keep everything as simple as possible**
8. **Establish an effective quality system that involves everyone**
9. **Be willing to accept risks, but only those you truly understand**
10. **Make sure everyone has enough time, resources, and freedom to do things right**

Article #9

Instill Ownership and Responsibility (continued)

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I knew I was going to have problems writing a book sequentially like this and then distributing the articles (chapters?) monthly. Try as I might, I'm not able to get things the way I like them in a single attempt. I decided I had more to say about last month's topic: how to instill ownership through how we write requirements.

In last month's article, I asked you to put yourself in the shoes first of the contractor and then of the customer. Let's revisit the former situation. Suppose your customer says, "We want to keep the cost down, so let's not do any environmental testing of the spacecraft. You can verify requirements by analysis alone."

What do you do? Do you smartly click your heels and say, "Anything you want, boss," based on the premise that the customer is always right? Or do you say, "Wait a minute, here," instead?

You cannot let your customer dictate the verification plan. If the mission fails, your customer may not blame you (don't count on it, though!), but you will be written up in the next issues of *Space News* and *Aviation Week & Space Technology*: "XYZ Company's Spacecraft/Launch Vehicle Fails Again!"

How long do you think you'll stay in business?

No, the customer is not always right. Your company should have standards, and you need to stand up to your customer when asked to violate them. In the long run, a good customer will appreciate this and come back for more.

As I think I've mentioned several times in these articles, I was fortunate to have begun my career working for people who were committed to success. Through most of the 1980's, I worked on a single, large program in which the technical leaders had the right attitude. We did many things wrong on that program that drove cost with little value—remember my story of 900 strain gages from my first article?—but we did have the right attitude. Over time, our customer recognized this.

As is the case on many programs, our customer had hired a company to provide experienced engineers who would review the technical aspects of our design and verification activities. "Customer consultants" is the term, and many people in our industry roll their eyes in disgust upon hearing it. Customer consultants have a reputation of driving costly work that contractors believe is unnecessary. Some of that happened on our program, but not much.

Our diligence was apparent, and we soon had the trust of our customer. In design reviews, we demonstrated a sound engineering process and a sense of ownership. We hid nothing from our customer; if someone brought up a valid issue, we addressed it at the meeting or volunteered to take an action item. As a result, when we disagreed with the customer consultants, nine times out of ten our customer agreed with us. If the customer representative didn't say it, I know he was thinking "These guys have the problem under control."

Over the years, our customer backed off on verification requirements. No longer were we required to meet MIL-STD-1540; our customer expected us—as we expected ourselves—to develop and maintain a sound verification and quality assurance plan.

I have since been involved with programs in which the technical understanding and sense of ownership were lacking. I have sat in design reviews in which customer consultants drove the show—someone had to make sure the system worked, and it apparently wasn't going to be us. More than once I have heard engineers and managers on the contractor side—my side—respond to a technical issue by saying, "But that would be out of scope." Every time I heard that, I wanted to crawl under the table.

The program I worked on throughout the '80's was fun. Every chance you get, demonstrate competence and integrity to your customer, and your job will get fun, too.

Awarding Contracts

Many have criticized the government procurement process as perhaps the underlying reason for high cost in aerospace. I agree. At first glance, we might think that a system that awards contracts based on competitive bids would reduce cost. But evidence suggests the opposite.

My first article in this series criticized our industry's tendency to arbitrarily cut the design budget and development time as a strategy doomed to failure. With the competitive bid process, however, how else are companies able to win jobs? They must cut the design budget and reduce development time—and budget the entire program based on the assumption of encountering no problems—or they'll lose to some company that will.

Let's recall here the philosophy of W. Edwards Deming. One of his fourteen points was to end the practice of awarding business on price tag alone. Now, it's easy for us to argue that our procurement system also considers technical aspects of a proposed design and quality, but whom are we fooling? We are doing exactly what Deming told us not to do. The only way to win a competitive bid is to bid low.

Deming said instead to develop a strong relationship with a trusted supplier (his point being you won't have time to do that with more than one!), a supplier that consistently provides quality products. The underlying belief here is that quality saves money in the long run. What's more, bringing in a trusted supplier to help you design your system opens a huge door of potential savings.

This approach does not undermine competition between contractors; it in fact is the truest form of competition. Only by providing consistent quality at a fair price would you be able to remain a "trusted supplier." In Deming's world, suppliers understand that violating this trust would put them out of business.

The dilemma, of course, is that our government procures products with our tax dollars, so we should all have a fair chance to win contracts. Things are different in the government; people don't have the same motivation as commercial businesses have. A key role of our government is to provide jobs as opposed to showing a profit. As a result, the status of "trusted supplier" may not be awarded fairly. Thus, the government procurement system will never be able to follow Deming's advice verbatim. As is often the case, we need to find the underlying principle and learn to apply it.

Yes, the government must allow companies to compete for jobs, but the determining criterion does not have to be price tag. In last month's article, I suggested revamping the process of specifying requirements: specifying only what the product must be able to do and then requiring the potential contractor to develop not only a design but also a plan for verification and quality assurance. With this approach, the customer would be able to better predict quality and thus use that assessment as the key selection criterion. Contractors would learn, with this system, that key omissions in their plans—such as no mention of how to protect against random defects in materials—imply incompetence and result in a losing bid. Of course, as I mentioned last month, this approach requires a high level of understanding regarding key technical issues on the part of the customer's selection committee (Principle #2).

What I have a hard time understanding is why commercial programs, without the restrictions imposed on government organizations, often choose to follow the government procurement process. In a way, it makes sense. Many of those people were weaned on that process, and it's the only one they know. Compare it, though, with how you shop for

a personal physician: do you go with the one offering the lowest cost each time you get sick, or do you return to the one you trust?

Changing how we award contracts as suggested above may be painful at first, as we work through the inevitable problems. But, if we're successful, our new process would undeniably build ownership and improve quality.

Insurance

I know I'll get some argument here, but I firmly believe that insuring a space mission is wrong. Rather, I should say that it's wrong to buy insurance from a company that is otherwise not involved. It's wrong because it violates a principle: it takes responsibility from the people who should have it.

I can't imagine what is going on in the minds of people insuring a space mission. It's like providing insurance to Toyota: we'll give you \$100,000,000 if the next car you develop is a lemon. Can you imagine how many lemons Toyota would produce?

Or how about this: providing insurance to someone attending college—promising to pay \$100,000 to compensate for lost tuition, room, and board if that person doesn't study hard enough and thus flunks out.

Sure, there's a random element in whether a space mission will be successful or not, but mostly it boils down to good engineering, effective management, diligence, and adequate funding. We insure things we have little or no control over—our lives, our health—not irresponsible management.

When we purchase insurance to protect against mission failure, we clearly take away responsibility, not only from the contractor but also from ourselves, the customer. How many times have we heard—or thought—"We don't have enough time (or money) to address that issue; we'll just have to accept the risk," when we know the mission is insured? How many times have customers refused to give contractors enough money to do the job right because they allocated the money for insurance instead?

This is the gist of the problem: many of our industry's failures are attributable, at least in part, to a push by the customer to do things faster and cheaper—the same customer that is buying insurance!

If you're a potential customer for a space mission and you don't like the chances of failure, given the industry's track record over the past years, how about this: ask for a guarantee from the prime contractor. Of course, you'll have to pay for that guarantee—possibly as much as insurance would cost. Now, though, it's up the contractor to decide how to use that money.

You don't think this would work? The typical prime contractor is a huge corporation, with far more resources than the typical insurance company. Why wouldn't it work?

If a potential prime contractor won't guarantee the mission, find someone who will. I can't imagine any better way to help instill the right attitude on the part of your contractors.

Building Personal Responsibility In-House

In last month's article, I related how I had tried to ensure quality in a group I was leading by writing a detailed criteria document and then imposing it on them. Although written standards and criteria are important to quality, my approach did more harm than good in that it took away a feeling of responsibility. Sure, you could argue that my people were responsible for meeting the criteria. There are always exceptions, but most people lose motivation when working this way, and they feel as if they do not own the product.

People feel as if they own the product when they're given broad, clear responsibility toward that product and the freedom to carry that responsibility out. In my future article on the eighth principle, establishing an effective quality system, I'll pursue this topic. For now, recognize the importance of clearly defining responsibilities, to ensure not only quality but also efficiency. Recognize also that clear responsibilities cannot be in the form of a job description written by a Human Resources person. Someone must manage the process with a sound enough understanding of the things that can go wrong to be able to concisely define and then dole out responsibilities.

Once we've defined responsibilities, we must be careful not to detract from them with potential conflicts of interest. As an example, while managing my group of seventeen stress analysts, the program manager decided to start a policy that rewarded people for cost-savings suggestions. Rewards were monetary, based on a percentage of cost saved, and they could get quite large. Suddenly I found several of my people no longer diligently working to meet their responsibilities. Instead, they spent much of the day brainstorming ways to reduce cost. I found this distraction difficult enough to handle, but I put a stop to this practice in my group when it became apparent that some of the cost-savings ideas were to eliminate structural tests—tests that were initially identified as necessary by my group!

Try as I might, I could not get the program manager to see the potential conflict of interest his policy had started, and he refused to cancel or change it. So I called my people together and announced that, henceforth, I would veto any cost-savings suggestion coming from my group that was related our responsibility. Most of my people agreed, but with some, I was no longer very popular. And this, in turn, made quality suffer in my group.

If morale is low at your organization, you can bet the sense of personal ownership and responsibility is low, also. Perhaps it's lack of ownership that causes morale to be low, but often other things are at work, and it's hard to stay diligent when your head's in the toilet.

If you can't put your finger on the cause of low morale, pay closer attention. Maybe it's because your people just worked hard the past five years only to have the mission fail, and they see management not doing the right things to ensure success the next time. Maybe they just heard that overhead was cut (again), so there will be little or no investment in R&D or continuing education. Or maybe they found out the CEO just got a 50% raise after they were told business wasn't good enough to justify any more than 3% (again) for them. There are many possible reasons. Some pertain to positions or perks attained not through merit but by rank or some other arbitrary criteria.

Lou Arthur recalls his days at JPL in the '70s: Machinists worked to attain "Inspector" status, trusted positions of high responsibility. Inspectors were recognized as craftsmen and had the respect of all. (What qualifications must a typical Quality Inspector have today?).

JPL awarded personal parking spots based on time of service. The best parking spots read like a "who's who" at JPL—except for one spot. Most visitors recognized the name on the first spot as belonging to the lab director; the third belonged to the second in command. The second spot said "Jake."

"Who's Jake?" people would ask.

"Oh, he's our janitor. Only the lab director has worked at JPL longer than Jake."

Closing Remarks

You may be thinking many of the things I proposed in this and last month's articles are fine ideals but unreachable ones. You're probably thinking of contractors you've had

so much trouble with: how could you possibly let them decide how to test their products or what structural factors of safety to use? And how could we change how contracts are awarded, as I suggested, given current procurement regulations?

Yes, there are some challenging problems to work through. In my mind, though, it's a principle that, for cost-effective quality, the people doing the work must feel ownership. Thus, we must overcome any problems impeding that feeling.

About the Author

Tom Sarafin has been involved in the space industry full time since 1979, at which time he graduated from The Ohio State University with a BS in civil engineering and took a job as a stress analyst at Martin Marietta Astronautics in Denver, Colorado. While at Martin, he was involved with design, analysis, verification planning, and testing on several spacecraft and launch vehicle programs. After contributing to the book *Space Mission Analysis and Design* [Larson and Wertz, editors, first edition published in 1991], he obtained management's support and funding at Martin Marietta for the development of a book on the interdisciplinary development of structures for space missions, and served as principal author and editor for 23 other authors. He left Martin Marietta in 1993 to complete this book, under the guidance of Dr. Wiley Larson at the U.S. Air Force Academy. The result of nearly four years work—*Spacecraft Structures and Mechanisms: From Concept to Launch*—was published in 1995 jointly by Microcosm, Inc., and Kluwer Academic Publishers.

In 1993, Mr. Sarafin formed his own company, Instar Engineering and Consulting, Inc. Once he finished his book, he began providing review and advice as a consultant to space programs. He also developed a short course based on his book and began teaching it throughout the industry. The course has been quite popular, and the business has grown. Now Instar offers a curriculum of courses taught by experienced engineers and continues to add to that curriculum.

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