CHAPTER 20

MANAGEMENT CONSIDERATIONS AND SUMMARY

20.1 MANAGEMENT CONSIDERATIONS

The Acquisition Reform Environment

No one involved in systems acquisition, either within the department or as a supplier, can avoid considering how to manage acquisition in the current reform environment. In many ways, rethinking the way we manage the systems engineering process is *implicit* in reforming acquisition management. Using performance specifications (instead of detailed design specifications), leaving design decisions in the hands of contractors, delaying government control of configuration baselines—all are reform measures related directly to systems engineering management. This text has already addressed and acknowledged managing the technical effort in a reform environment.

To a significant extent, the systems engineering processes—and systems engineers in general—are victims of their own successes in this environment. The systems engineering process was created and evolved to bring discipline to the business of producing very complex systems. It is intended to ensure that requirements are carefully analyzed, and that they flow down to detailed designs. The process demands that details are understood and managed. And the process has been successful. Since the 1960s manufacturers, in concert with government program offices, have produced a series of ever-increasingly capable and reliable systems using the processes described in this text. The problem is, in too many cases, we have overlaid the process with ever-increasing levels of controls, reports, and reviews. The result is that the cycle time required to produce systems has increased to unacceptable levels, even as technology life cycles have decreased precipitously. The fact is that, in too many cases, we are producing excellent systems, but systems that take too long to produce, cost too much, and are often outdated when they are finally produced. The demand for change has been sounded, and systems engineering management must respond if change is to take place. The question then becomes how should one manage to be successful in this environment? We have a process that produces good systems; how should we change the process that has served us well so that it serves us better?

At the heart of acquisition reform is this idea: we can improve our ability to provide our users with highly capable systems at reasonable cost and schedule. We can if we manage design and development in a way that takes full advantage of the expertise resident both with the government and the contractor. This translates into the government stating its needs in terms of performance outcomes desired, rather than in terms of specific design solutions required; and, likewise, in having contractors select detailed design approaches that deliver the performance demanded, and then taking responsibility for the performance actually achieved.

This approach has been implemented in DoD, and in other government agencies as well. In its earlier implementations, several cases occurred where the government managers, in an attempt to ensure that the government did not impose design solutions on contractors, chose to deliberately distance the government technical staff from contractors. This presumed that the contractor would step forward to ensure that necessary engineering disciplines and functions were covered. In more than one case, the evidence after the fact was that, as the government stepped back to a less directive role in design and development, the contractor did not take a corresponding step forward to ensure that normal engineering management disciplines were included. In several cases where problems arose, after-the-fact investigation showed important elements of the systems engineering process were either deliberately ignored or overlooked.

The problem in each case seems to have been failure to communicate expectations between the government and the contractor, compounded by a failure on the part of the government to ensure that normal engineering management disciplines were exercised. One of the more important lessons learned has been that while the systems engineering process can—and should be—tailored to the specific needs of the program, there is substantial risk ignoring elements of the process. Before one decides to skip phases, eliminate reviews, or take other actions that appear to deliver shortened schedules and less cost, one must ensure that those decisions are appropriate for the risks that characterize the program.

Arbitrary engineering management decisions yield poor technical results. One of the primary requirements inherent in systems engineering is to assess the engineering management program for its consistency with the technical realities and risks confronted, and to communicate his/her findings and recommendations to management. DoD policy is quite clear on this issue. The government is not, in most cases, expected to take the lead in the development of design solutions. That, however, does not relieve the government of its responsibilities to the taxpayers to ensure that sound technical and management processes are in place. The systems engineer must take the lead role in establishing the technical management requirements for the program and seeing that those requirements are communicated clearly to program managers and to the contractor.

Communication – Trust and Integrity

Clearly, one of the fundamental requirements for an effective systems engineer is the ability to communicate. Key to effective communication is the rudimentary understanding that communication involves two elements—a transmitter and a receiver. Even if we have a valid message and the capacity for expressing our positions in terms that enable others to understand what we are saying, true communication may not take place if the intended receiver chooses not to receive our message. What can we do, as engineering managers to help our own cause as far as ensuring that our communications are received and understood?

Much can be done to condition others to listen and give serious consideration to what one says, and, of course, the opposite is equally true—one can condition others to ignore what he/she says. It is primarily a matter of establishing credibility based on integrity and trust.

First, however, it is appropriate to discuss the systems engineer's role as a member of the management team. Systems engineering, as practiced in DoD, is fundamentally the practice of engineering management. The systems engineer is expected to integrate not only the technical disciplines in reaching recommendations, but also to integrate traditional management concerns such as cost, schedule, and policy into the technical management equation. In this role, senior levels of management expect the systems engineer to understand the policies that govern the program, and to appreciate the imperatives of cost and schedule. Furthermore, in the absence of compelling reasons to the contrary, they expect support of the policies enunciated and they expect the senior engineer to balance technical performance objectives with cost and schedule constraints.

Does this mean that the engineer should place his obligation to be a supportive team member above his ethical obligation to provide honest engineering judgment? Absolutely not! But it does mean that, if one is to gain a fair hearing for expression of reservations based on engineering judgment, one must be viewed as a member of the team. The individual who always fights the system, always objects to established policy, and, in general, refuses to try to see other points of view will eventually become isolated. When others cease listening, the communication stops and even valid points of view are lost because the intended audience is no longer receiving the message—valid or not.

In addition to being team players, engineering managers can further condition others to be receptive to their views by establishing a reputation for making reasoned judgments. A primary requirement for establishing such a reputation is that managers must have technical expertise. They must be able to make technical judgments grounded in a sound understanding of the principles that govern science and technology. Systems engineers must have the education and the experience that justifies confidence in their technical judgments. In the absence of that kind of expertise, it is unlikely that engineering managers will be able to gain the respect of those with whom they must work. And yet, systems engineers cannot be expert in all the areas that must be integrated in order to create a successful system. Consequently, systems engineers must recognize the limits of their expertise and seek advice when those limits are reached. And, of course, systems engineers must have built a reputation for integrity. They must have demonstrated a willingness to make the principled stand when that is required and to make the tough call, even when there are substantial pressures to do otherwise.

Another, perhaps small way, that engineers can improve communication with other members of their teams (especially those without an engineering background) is to have confidence in the position being articulated and to articulate the position concisely. The natural tendency of many engineers is to put forward their position on a subject along with all the facts, figures, data and required proofs that resulted in the position being taken. This sometimes results in explaining how a watch works when all that was asked was "What time is it?" Unless demonstrated otherwise, team members will generally trust the engineer's judgment and will assume that all the required rationale is in place, without having to see it. There are some times when it is appropriate to describe how the watch works, but many times communication is enhanced and time saved by providing a confident and concise answer.

When systems engineers show themselves to be strong and knowledgeable, able to operate effectively in a team environment, then communication problems are unlikely to stand in the way of effective engineering management.

20.2 ETHICAL CONSIDERATIONS

The practice of engineering exists in an environment of many competing interests. Cost and schedule pressures; changes in operational threats, requirements, technology, laws, and policies; and changes in the emphasis on tailoring policies in a common-sense way are a few examples. These competing interests are exposed on a daily basis as organizations embrace the integrated product and process development approach. The communication techniques described earlier in this chapter, and the systems engineering tools described in earlier chapters of this book, provide guidance for engineers in effectively advocating the importance of the technical aspects of the product in this environment of competing interests.

But, what do engineers do when, in their opinion, the integrated team or its leadership are not putting adequate emphasis on the technical issues? This question becomes especially difficult in the cases of product safety or when human life is at stake. There is no explicit set of rules that directs the individual in handling issues of ethical integrity. Ethics is the responsibility of everyone on the integrated team. Engineers, while clearly the advocate for the technical aspects of the intgrated solution, do not have a special role as ethical watchdogs because of their technical knowledge.

Richard T. De George in his article entitled *Ethical Responsibilities of Engineers in Large Organizations: The Pinto Case*[1] makes the following case: "The myth that ethics has no place in engineering

[1] *Ethical Issues in Engineering*, Johnson, Ch 15.

has been attacked, and at least in some corners of the engineering profession been put to rest. Another myth, however, is emerging to take its place—the myth of the engineer as moral hero."

This emphasis, De George believes, is misplaced. "The zeal of some preachers, however, has gone too far, piling moral responsibility upon moral responsibility on the shoulders of the engineer. Though engineers are members of a profession that holds public safety paramount, we cannot reasonably expect engineers to be willing to sacrifice their jobs each day for principle and to have a whistle ever by their sides ready to blow if their firm strays from what they perceive to be the morally right course of action."

What then is the responsibility of engineers to speak out? De George suggests as a rule of thumb that engineers and others in a large organization are morally permitted to go public with information about the safety of a product if the following conditions are met:

1. If the harm that will be done by the product to the public is serious and considerable.

2. If they make their concerns known to their superiors.

3. If, getting no satisfaction from their immediate supervisors, they exhaust the channels available within the operation, including going to the board of directors (or equivalent).

De George believes if they still get no action at this point, engineers or others are morally permitted to make their concerns public but not morally obligated to do so. To have a moral obligation to go public he adds two additional conditions to those above:

4. The person must have documented evidence that would convince a reasonable, impartial observer that his/her view of the situation is correct and the company policy wrong.

5. There must be strong evidence that making the information public will in fact prevent the threatened serious harm.

Most ethical dilemmas in engineering management can be traced to different objectives and expectations in the vertical chain of command. Higher authority knows the external pressures that impact programs and tends to focus on them. System engineers know the realities of the on-going development process and tend to focus on the internal technical process. Unless there is communication between the two, misunderstandings and late information can generate reactive decisions and potential ethical dilemmas. The challenge for system engineers is to improve communication to help unify objectives and expectations. Divisive ethical issues can be avoided where communication is respected and maintained.

20.3 SUMMARY

The material presented in this book is focused on the details of the classic systems engineering process and the role of the systems engineer as the primary practitioner where the activities included in that process are concerned. The systems engineering process described has been used successfully in both DoD and commercial product development for decades. In that sense, little new or revolutionary material has been introduced in this text. Rather, we have tried to describe this time-proven process at a level of detail that makes it logical and understandable as a tool to use to plan, design, and develop products that must meet a defined set of requirements.

In DoD, systems engineers must assume roles of engineering managers on the program or project assigned. They must understand that the role of the systems engineer is necessarily different from that normal to the narrowly specialized functional engineer, yet it is also different from the role played by the program manager. In a sense, the role of the systems engineer is a delicate one, striving to balance technical concerns with the real management pressures deriving from cost, schedule, and policy. The systems engineer is often the person in the middle; it is seldom a comfortable position. This text has been aimed at that individual.

The first two parts of the text were intended to first give the reader a comprehensive overview of systems engineering as a practice and to demonstrate the role that systems engineering plays within the DoD acquisition management process. Part 2, in particular, was intended to provide relatively detailed insights into the specific activities that make up the process. The government systems engineer may find him/herself deeply involved in some of the detailed activities that are included in the process, while less involved in others. For example, government systems engineers may find themselves very involved in requirements definition and analysis, but less directly involved in design synthesis. However, the fact that government engineers do not directly synthesize designs does not relieve them from a responsibility to understand the process and to ensure that sound practices are pursued in reaching design decisions. It is for this reason that understanding details of the process are critical.

Part 3 of the book is perhaps the heart of the text from an engineering management perspective. In Part 3, we have presented discussions on a series of topics under the general heading of Systems Analysis and Control. The engine that translates requirements into designs is defined by the requirements analysis, functional analysis and allocation, and design synthesis sequence of activities. Much of the role of the systems engineer is to evaluate progress, consider alternatives, and ensure the product remains consistent and true to the requirements upon which the design is based. The tools and techniques presented in Part 3 are the primary means by which a good engineering management effort accomplishes these tasks.

Finally, in Part 4, we presented some of the considerations beyond the implementation of a disciplined systems engineering process that the engineering manager must consider in order to be successful. Particularly in today's environment where new starts are few and resources often limited, the planning function and the issues associated with product improvement and integrated team management must move to the forefront of the systems engineer's thinking from the very early stages of work on any system.

This book has attempted to summarize the primary activities and issues associated with the conduct and management of technical activities on DoD programs and projects. It was written to supplement the material presented courses at the Defense Systems Management College. The disciplined application of the principles associated with systems engineering has been recognized as one indicator of likely success in complex programs. As always, however, the key is for the practitioner to be able to absorb these fundamental principles and then to tailor them to the specific circumstances confronted. We hope that the book will prove useful in the future challenges that readers will face as engineering managers.