Testimony of

Dr. PEDRO "PETE" L. RUSTAN

Director, Advanced Systems and Technology

National Reconnaissance Office

UNITED STATES HOUSE OF REPRESENTATIVES

HOUSE ARMED SERVICES COMMITTEE

HearingHEARING

SPACE ACQUISITION

12 July 12, 2005

Mr. Chairman and members of the Committee, I am honored and privileged to appear before you today to speak about improving acquisition processes for space systems.

I think space acquisition procedures are the biggest challenge facing our space systems today. We must do things differently. Unless decisive actions are taken, I think we will continue to spend large amounts of money without returning a commensurate capability to our stakeholders.

The U.S. gGovernment manages tens of billions of dollars to build and operate space systems. These systems provide essential capabilities in the following functional areas: position, navigation and timing; missile warning and surveillance; intelligence, surveillance and reconnaissance; environmental sensing; communications; space control; and space science and exploration. Unfortunately, during the last 15 years, a negative trend has developed with respect to the procedures the Government uses to acquire U.S. space systems. In the pursuit of accommodating the needs of various stakeholders, we have developed strict requirements-based processes that are having adverse, unintended consequences. I think we need to transform today's organizational culture and processes used to acquire our space systems. I would like to discuss ten major problems in our management of space systems acquisition today. For each case, I will describe the problem and provide my specific, constructive recommendations on how to solve it.

Problem	Solution
1. Overly detailed requirements from the stakeholders with little flexibility.	Describe only the expected performance attributes, approximate schedules and suggested funding profiles.
2. Proceeding to acquisition before proper technology maturity.	Build the critical technologies to sufficient maturity to prevent technology surprises during the acquisition cycle.
3. Insufficient budget flexibility.	Reduce the number of expenditure centerexpenditure centers (ECs) and line items, and provide some margin reserve.
4. Requirements creep after program initiation.	Resist stakeholders' desires to increase program capabilities late in the acquisition process.
5. Management experience shortfalls in space acquisition results in too many people in program offices.	Train/hire an elite cadre of government experts and minimize personnel rotation. Hold government managers accountable.
6. Incomplete requirements flow down to subsystems to meet expected performance.	Work with contractors to ensure all implementation requirements have been properly transferred to subsystems.
7. Failure to properly manage subcontractors.	Encourage start of all subcontractors soon after program authority to proceed and ensure proper subcontractor management.
8. Uncertainties in the expected performance and schedule of the new generation of electronic components.	Ensure mature manufacturing processes with validated performance have been developed for all selected components.
9. Tendency to build a new spacecraft for each new set of requirements.	Develop standard interfaces, modular approaches, and plug and play whenever possible.
10. Responsibility for the development of only on-orbit capabilities exclusive of requisite ground services.	Evaluate end-to-end systems and work with our partners to process, exploit and deliver the capabilities.

1. Overly detailed requirements from the stakeholders with little flexibility.

During the first 30 years of the space program, we built capability-driven systems that provided the best that our advanced technologies could offer. That strategy worked well in offering innovative solutions, but it did not always represent the customers'' needs. During the last 15 years, however, we have swung the pendulum to the other extreme by collecting overly broad requirements sets that our space systems should meet. This strict requirements-driven process often includes mutually exclusive capabilities that cannot be easily integrated on the same spacecraft. When we attempt to do so, it can drive significant increases in cost and schedule. Our requirements-driven stakeholders often do not understand the cost implications of the various elements of their respective wish lists, and when we proceed to blindly integrate these capabilities, considerable problems develop. This problem is exacerbated when we are asked to hold fixed performance, cost and schedule at the beginning of any space acquisition, thereby inexorably increasing program risk.

Instead, we should develop more discipline; to understand the needs of the stakeholders. We must listen to their needs and build systems to connect their basic needs to expected performance attributes for a proposed system, the approximate schedule, and the expected funding profile. If problems develop, I think we should have the flexibility to trade

performance in lieu of cost. If we choose to extend schedule, we have to be willing to increase program cost.

2. Proceeding to acquisition before proper technology maturity.

Enthusiastic stakeholders and space program managers often advocate and start programs to build a spacecraft before the critical technologies have been matured. As a result, we often have to spend years developing the technologies as part of the acquisition with big cost penalties for feeding a large acquisition army when delays occur.

Instead, I think we should build critical payload subsystems first under cost-plus contracts prior to major procurements in order to mitigate technology risk. Once the payload critical technologies, subsystems, and systems have been built and properly tested, the more conventional spacecraft integration and test of those systems can often be performed, and the systems built, using accelerated schedules in an advantageous combination of firm fixed price for basic functions and cost plus overlay to ensure increased testing and complete mission assurance.

3. Insufficient budget flexibility.

It is difficult to manage our space acquisition programs today without having the budget flexibility to solve problems as soon as they develop. I think program managers are trapped by

very specific budget constraints when their programs are partitioned in proliferate expenditure centerECs and line items, and they are overly limited in the money that can be transferred between programs. Since the contractors feel pressured to provide optimistic budget proposals to win programs, this lack of budget flexibility prevents us from solving problems as soon as we observe early symptoms. Fewer expenditure centerECs and line items would give greater flexiblityflexibility to move money among them so that we can be more effective managers. I recommend execution year reserves for space acquisition programs. I am not suggesting these reserves be implemented with no oversight. These reserves should be used judiciously by program managers to solve problems during program execution with the program manager's supervisor providing the proper accountability for execution of those funds.

4. Requirements creep after program initiation.

Since there are many users impacted by the capabilities and operations of our space systems today, there is an inclination by many of these stakeholders to request increased capabilities for the various specific programs being pursued during the acquisition cycle. These stakeholders are driven by the need to address a dynamic target set and/or the appeal of new technology perceived to increase capabilities. Even though these motives are laudable, they do have negative impacts on program system acquisition.

Program managers should resist stakeholders' desires to increase program capabilities late in the acquisition cycle.

5. Management experience shortfalls in space acquisition results in too many people without the requisite experience in program offices.

To manage complex programs, we need a highly trained workforce with the correct skill set. It has become difficult to find the requisite trained expertise in government to run major programs. I think we tend to compensate by significantly increasing the workforce numbers to obtain the expertise through collective thinking and prescribed processes involving many government and support personnel. The unintended consequences are that contractors are compelled to match one-for-one the size of their respective government program office, resulting in value reduction on both sides.

I think we should also pay more attention to the technical training of our workforce and hire greater expertise in government, while minimizing personnel rotations. Consequently, we could better empower program managers to make decisions in their programs and hold the managers accountable for their actions. We should carefully select trained program managers to ensure the correct balance of knowledge and experience.

6. Incomplete requirements flow down to subsystems to meet expected performance.

In many cases, I have observed that prime contractors fail to perform a detailed system engineering analysis during the first few months of program execution, and some requirements are inadvertently not communicated to some tiers of subcontractors.

When these problems are not found until several years after the beginning of the program, they result in major cost impacts to the project.

I think we should work with contractors to ensure that all implementation requirements to meet the contracted capabilities have been properly flowed down to the subcontractors. The flow down should include both the system level and the environmental requirements.

7. Failure to properly manage subcontractors.

Encourage the quick start and proper management of subcontractors. It takes many months and often years for a prime contractor to finalize the specifications for subcontractors and put those subcontractors to work for the prime. This slow pace at the beginning of the program has a detrimental impact on total program cost and schedule. Once under contract, prime contractors often do not fully integrate subcontractors' program management plans and management schedules into the prime's integrated master plans and integrated master schedules. As a result, there are frequent

surprises in program execution with adverse cost and schedule impacts. I have also noted that different aerospace companies exhibit different management styles when dealing with the subcontractors. Those companies that consider subcontracting program management a valuable step in career progression and position their best talented technical individuals in those jobs, do significantly better than those companies that consider subcontracting management a business support function.

I think we should work with industry to ensure there is sufficient maturity in the description of the work being proposed by subcontractors at the time of proposal submission so the prime can finalize subcontractor tasks during the first few months after contract award. Then, the prime contractor should manage the subcontractors with authority by imposing strict discipline in the work that has to be done to ensure proper compliance to performance, cost, and schedule. All subsystem deliverables essential for program execution should be integrated in the master plan and master schedule.

8. Uncertainties in the expected performance and schedule of the new generation of electronic components.

With the tremendous advances in the semiconductor and microchip industries during the last 15 years, great numbers of traditionally separate components are now integrated into more complex single parts. Since these components are evolving

quickly, the companies involved as primes, contractors, and subcontractors tend to go out independently to obtain their electronic components from the industrial base without important compliance checks. Problems of flawed manufacturing or immature processes in some of the electronic vendors, found only late in system testing, have significantly impacted program costs and schedules.

I think we should work with industry and the Aerospace Corporation to ensure mature manufacturing processes are used and there is no overdependence on any one vendor. Redundant procurements must be used at the beginning of programs if there is a sufficiently high risk of time delays by depending on a single parts contractor. Finally, to achieve mission assurance, I think the Government must take an active role managing the parts and materials approval process.

9. Tendency to build a new spacecraft for each new set of requirements.

In spite of the great demand for the use of satellites to meet defense, intelligence, and commercial applications, I think spacecraft manufacturers have a propensity to build a different spacecraft for each specific application. Even though all spacecraft use the same basic bus support functions such as power, structure, attitude control, thermal, propulsion, and communication, and some of the components and many of the

subsystems are the same, there is still a paucity of commonality. It often seems every spacecraft is designed using a clean a sheet of paper.

I think we should work with industry to encourage the development of standard interfaces, modular approaches and plug and play configurations whenever possible. If a spacecraft constellation using identical systems is being implemented, we should build them using the same framework implemented in the aircraft industry using production assembly lines. Emphasizing distributed constellations and production assembly lines, we should reap increased capabilities by providing multiple redundancies while reducing overall cost.

10. Responsibility for the development of only on-orbit capabilities exclusive of requisite ground services.

I think it is essential that we do not isolate the responsibilities of the space system acquisition agency (such as the National Reconnaissance Office) from the responsibility of the organizations responsible for exploitation and dissemination of the product (such as the National Security Agency or the National Geospatial-Intelligence Agency). We should carefully analyze the questions we are trying to answer, determine if space is the best medium to obtain that information, and proceed to perform an end-to-end analysis of all the elements required to convert the collected data into information for decision-making. The ground infrastructure required to command and

control the spacecraft and process, exploit, and distribute the resulting information, is just as demanding as the space systems. When we fail to work in perfect alignment with the various other players, delays occur because not all the elements of the complex system are ready when needed. I think the space system producers should share end-to-end responsibility for system performance.

I think we should evaluate the end-to-end system and work with our partners to process, exploit, and deliver our capabilities.

In conclusion, I have described what I believe the processes, culture, and technology challenges are besetting the Department of Defense and the Intelligence Community (IC) space systems organizations today and provided specific recommendations on corrective actions. We must be resolute pursuing effective solutions to today's problems. I think it is critical to move away from the requirements-driven procedures in place today so we can have the flexibility to describe the expected performance attributes of proposed systems, their approximate schedule and the proposed funding profile. We must not fix all three fundamental contract parameters (performance, schedule, and cost) in any space acquisition in order to avoid expanding program risk exponentially. I think there should be a common approach for the acquisition of both small and large

spacecraft. If we follow these recommendations, we can develop effective business models that apply to the entire industry.

I remain deeply concerned that the culture and processes that we have come to accept as the *de facto* standard operating procedure do not represent the best framework for the enhanced capabilities that we need to provide to the military and the intelligence communityIC. We must transform the ways we do business, become much more proactive and effective in satellite acquisition program management. Our challenge is to return more to the nation for resources invested. To rise to this challenge and continue to be the leading space faring nation, I think we must modify, streamline, or eliminate some of the processes and

change the culture to which we have become accustomed during the last 15 years. We must learn from our mistakes, galvanize our efforts, and move forward to transform our space acquisition processes now.

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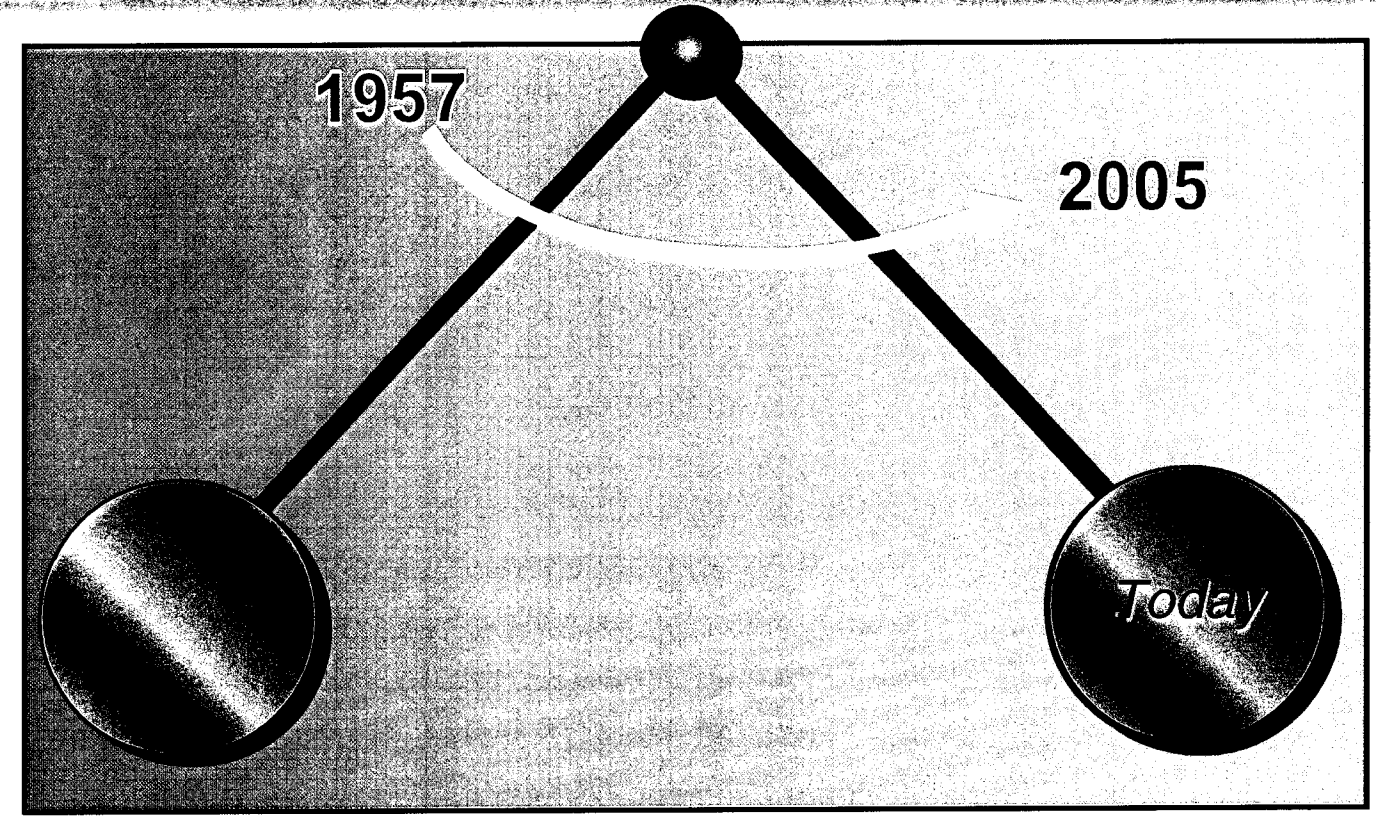
US Defense Space Acquisition Problems and Potential Solutions

Presented to the Defense Acquisition Performance Assessment Project

Pete Rustan

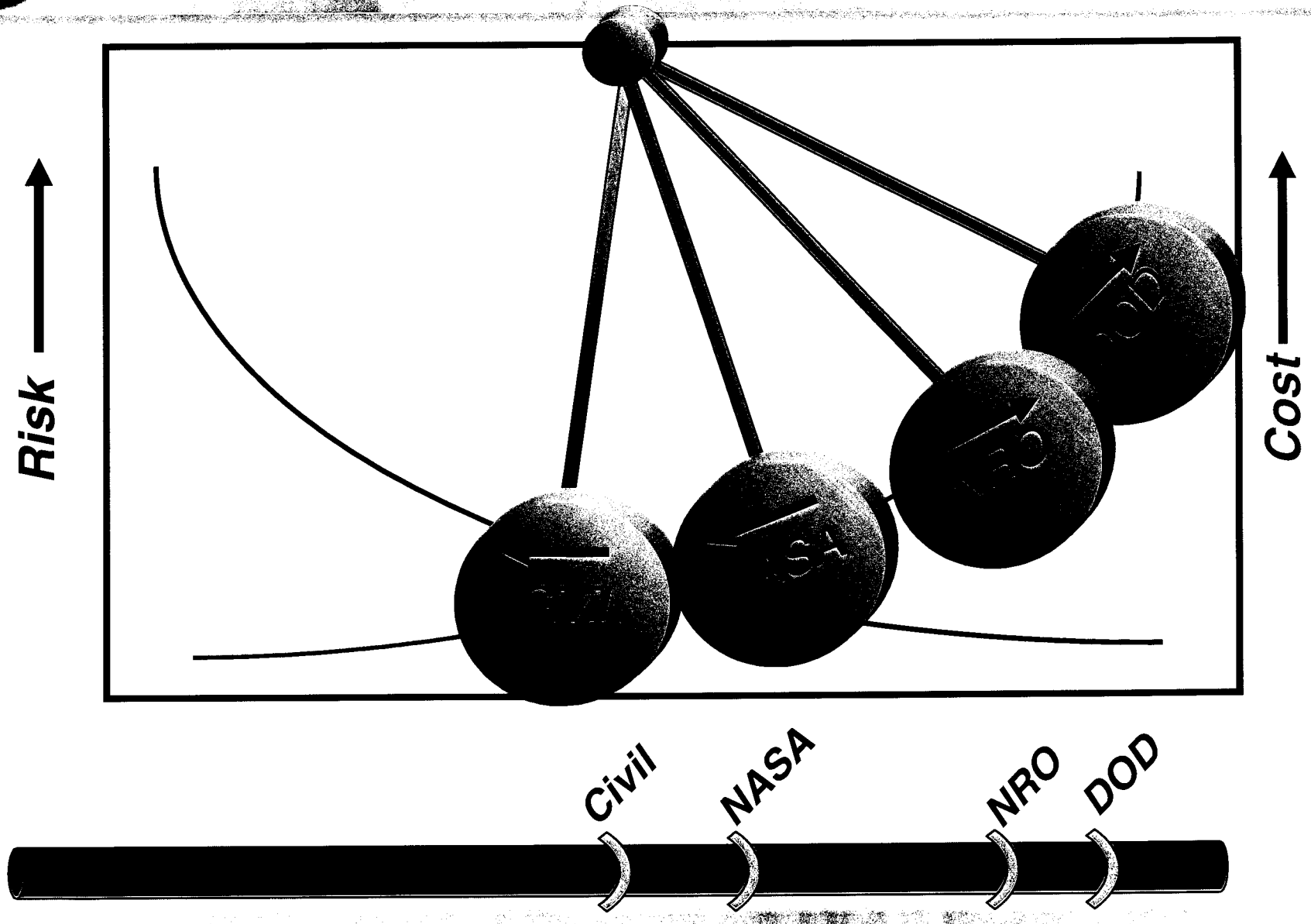
September 15, 2005

Program Management Pendulum

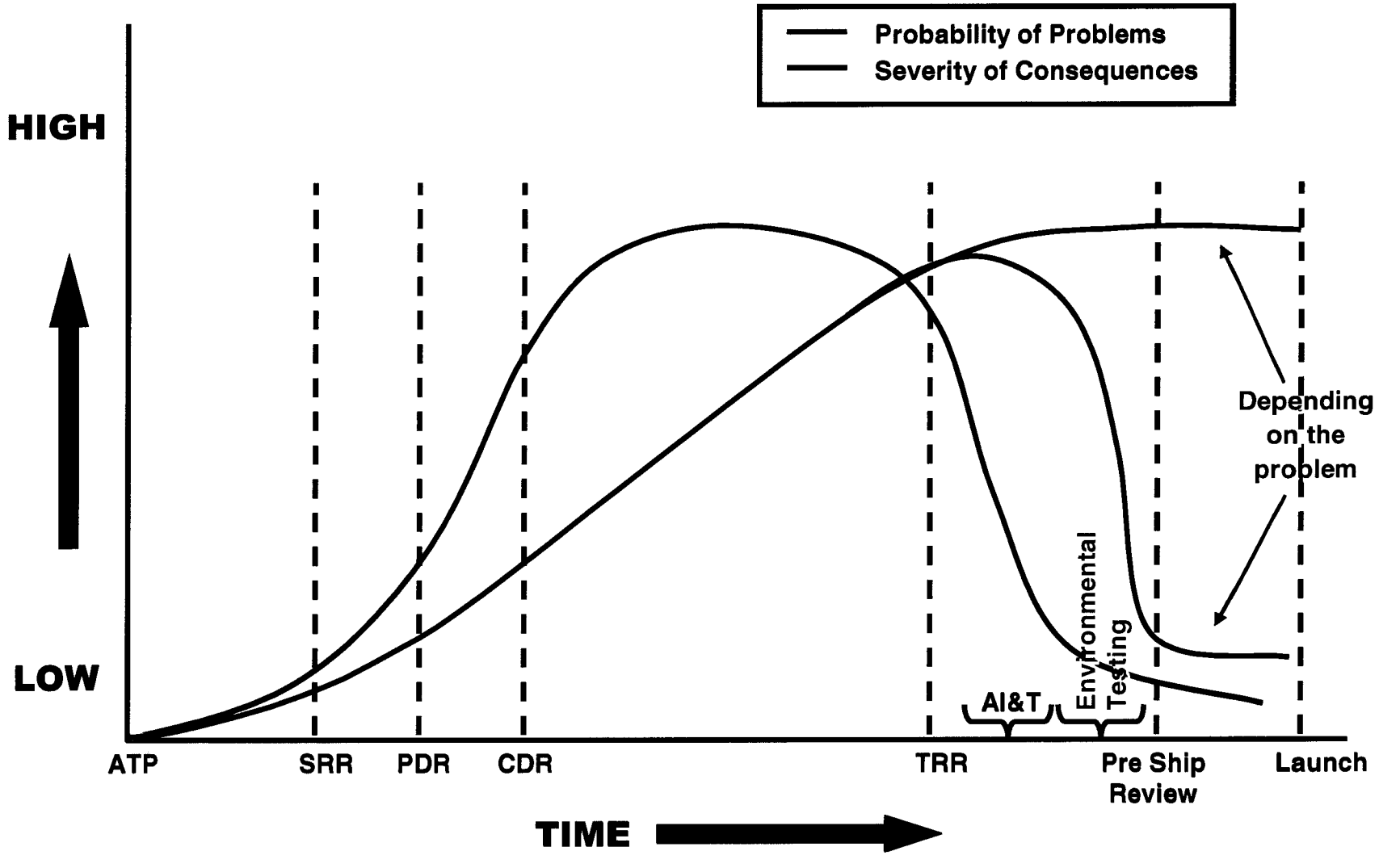


Technology-Driven	*Requirements Driven*
Risk Management	*Risk Averse*
Streamlined Mgmt Processes	*Process Driven Mgmt Practices*
Skunkworks	*Layers of Review*
Budget Flexibility	*Budget Constraints*

User's 2005 Risk Tolerance



Space Acquisition – Problems And Consequences Over Time



The Box We've Put Ourselves In

Schedule

- **Minimum 5 to 7 years, ATP to launch, often 10 years**
- **Lengthy and complicated proposals**
- **Parts availability**
- **Detailed and lengthy testing**

Cost

- **Hundreds of millions or billions of dollars per satellite**
- **System engineering difficulties**
- **Part survivability**

Performance

- **Extensive and detailed requirements**
- **Long satellite life requirement**
- **Scarcity of new technology innovations**

Risk

- **Slow schedule drives cost**
- **Added requirements drive cost**
- **Low risk implies no innovation**
- **Space components small production capability**

Can we reform acquisition processes to move to lower cost while achieving mission assurance?

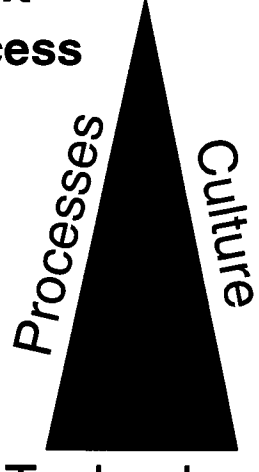
Culture, Processes And Technology

TODAY → TOMORROW

Where We Are

Present approach is dominated by:

- **An unconstrained requirements driven process**
- **Low rate of new technology insertion being performed after ATP**
- **Integration of multiple missions on each spacecraft**
- **Mission success**
- **Risk Averse**

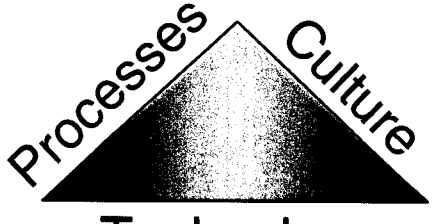


(A Culture and Process Driven Strategy)

Where We Need to Be

We must focus on:

- **Cost as an Independent Variable (CAIV)**
- **Technology opportunities to develop enhanced capabilities performed prior to ATP**
- **Single or synergistic missions only integrated on each spacecraft**
- **Mission success using streamlined management procedures**
- **Active Risk Management**



(A Balanced Approach)

Ten Major Space Defense Acquisition Problems And Potential Solutions

#1 Overly Detailed And Inflexible Requirements

- **Problem: Initially in the space era, we built capability-driven systems that provided the best our technologies could offer. During the last 15 years, however, we have swung the pendulum to writing detailed requirements that our space systems should meet.**

- **Solution: We should develop more discipline to understand the needs of the stakeholders. But if problems develop, we should have the flexibility to trade performance in lieu of increased cost.**

#2 Proceeding To Acquisition Before Technologies Mature

- **Problem: Enthusiastic stakeholders often start programs to build a spacecraft before the critical technologies have matured. As a result, we often spend years developing the technologies as part of acquisition, with big cost penalties.**

- **Solution: We should build critical payload subsystems first under cost-plus contracts. Then, the more conventional spacecraft development and integration can be performed resulting in an accelerated schedule at lower cost.**

#3 Inflexible Budgets

- **Problem: It is difficult to manage acquisition without the budget flexibility to solve problems as they develop. Program managers are trapped by very specific budget constraints and limited in money that can be transferred between programs. Since contractors feel pressured to provide optimistic budget proposals to win programs, this lack of budget flexibility prevents us from solving problems as soon as we observe early symptoms. Continuing changes by Congress and/or program offices to program budgets and schedules have a serious detrimental impact on program cost.**

- **Solution: We need execution-year reserves for space acquisition programs, but the reserves should be used judiciously by program managers and only with approval of the program manager's supervisor.**

#4 Requirements Creep

- **Problem: Since there are many users of our space systems today, and it takes many years to build the systems, the situation changes and stakeholders often request increased capabilities during the acquisition cycle.**

- **Solution: Even though these stakeholders' motives are laudable, program managers should resist their desires to increase capabilities in the acquisition cycle. Shortening the acquisition cycle will discourage program changes.**

#5 Management Experience Shortfalls

- **Problem: We tend to compensate for our present paucity of management experience by significantly increasing the workforce numbers to obtain the expertise through collective thinking, prescribed processes and committee recommendations. Contractors feel compelled to match one-for-one the size of their respective government program offices, driving program costs up considerably.**

- **Solution: We should hire greater expertise in government, minimize personnel rotations, reduce the size of the government program offices and support contractors and empower program managers to make decisions and hold them accountable.**

#6 Poor Management Of Subcontractors

- **Problem: It takes months or years for a prime contractor to finalize specifications and put subcontractors to work. In many cases, prime contractors fail to perform a detailed system engineering analysis during the first few months of program execution, and some requirements are inadvertently not communicated to subcontractors.**

- **Solution: The government should require strict requirements flowdown and finalization of all subcontractors within six months after ATP. The prime contractors should fully integrate and track subcontractor's management plans and acquisitions schedules into the Prime's master schedule. Companies should consider management of subcontractors a step in career development instead of a business support function.**

#7 Uncertainties About Electronic Components

- **Problem: With the tremendous advances in electronics in the last 15 years, great numbers of traditionally separate components are now integrated into more complex single parts. Since these components are evolving quickly, the companies involved tend to go out independently to obtain their electronic components from the industrial base without compliance checks. Flawed manufacturing or immature processes are often found only late in system testing.**

- **Solution: Government should work with industry to ensure a vital component of the industrial base by continuously maturing manufacturing processes. Government should prevent overdependence on any one vendor.**

#8 New Spacecraft For Each Set Of Requirements

- **Problem: In spite of the continuing demand for satellites to meet defense, intelligence and commercial applications, manufacturers have a propensity to build a different spacecraft for each specific application. Even though all spacecraft use the same basic bus support functions (power, structure, attitude, command and control, thermal, propulsion and communication) and some of the components are the same, using off the shelf components is not a standard procedure.**

- **Solution: We should encourage the development of standard interfaces, modular approaches and plug-and-play configurations. We should also emphasize distributed satellite constellations and production assembly lines.**

#9 Forgetting About Ground Services

- **Problem: Too often, we isolate acquisition from the organizations responsible for exploitation and dissemination of the product. We should carefully analyze the questions we are trying to answer, determine if space is the best medium to obtain that information, and proceed to perform an end-to-end analysis of all the elements required to convert the collected data into information for decision-making.**

- **Solution: Ensure the ground infrastructure required to control the spacecraft, and process and distribute the resulting information, is fully evaluated and is an integral part of the acquisition process. Space system producers should share end-to-end responsibility for system performance.**

#10 Integrating Multiple Non-Synergistic Missions For Each Spacecraft Procurement

- **Problem: Spacecraft cost is directly related to the complexity of the system being built. Multiple non-synergistic functions drive program costs exponentially. Since we have few new starts, and launch vehicle costs are high, there is a tendency to integrate mutually exclusive requirements on the same spacecraft.**

- **Solution: Meet user requirements by building distributed architectures using constellations of satellites. Put non-synergistic missions on separate spacecraft, using plug and play and standard interfaces. We must also work to revitalize the small launch industry.**

We Must Do Things Differently

	Issue	Govt	Contr	Remarks
Technology	Immature Technology	√		Should be TRL 6 before building
Technology	SV Size/Weight/Capability	√	√	Centralized vs constellation options
Culture	Too Many People	√	√	Too much "support"
Culture	Unconstrained Rqmts	√		Independent of cost
Culture	Things to do by PDR	√	√	Ensure "paper" is ready for build
Processes	Insight Versus Oversight	√		PM must be in-charge
Processes	Value Proposition	√		Analyze capability versus cost
Processes	Historical Cost Models	√	√	Accepts previous mistakes
Processes	Parts Management	√	√	Govt must ensure proper mgmt
Processes	Sub-contract Management	√	√	Contractor must manage subs
Processes	Inflexible Budget	√		Reserve allocated for all programs
Processes	Rapid Prototyping	√		Utilize urgency to solve new problems

I strongly believe satellite cost can be reduced by at least 50% by addressing culture and process issues

Summary

- The culture and processes that we have come to accept as the de facto standard operating procedure do not represent the best framework for the enhanced capabilities that we need to provide to the military and the IC.
- We must transform the ways we do business, become much more proactive and effective in satellite acquisition program management. Our challenge is to return more to the nation for resources invested.
- To rise to this challenge and continue to be the leading space faring nation, I think we must modify, streamline, or eliminate some of the processes and change the culture to which we have become accustomed during the last 15 years. We must learn from our mistakes, galvanize our efforts, and move forward to transform our space acquisition processes now.