Defense Acquisition University

Intermediate Systems Acquisition Course

ACQ 203

(May 2016) Version 1.3.1

DAU strives to make you, the defense acquisition workforce, better at what you do. Your work is important to the nation and your learning is important to us. We constantly work to make the course more effective for you. Please let your instructor know how we can improve this course or feel free to send me an email.

Thanks,

Matt Ambrose

ACQ 203 Course Manager

matt.ambrose@dau.mil

DAU Learning Resources Available at www.dau.mil

Interactive DAU Catalog http://icatalog.dau.mil/

Continuous Learning Center - http://www.dau.mil/clc/

Defense Acquisition Portal - https://dap.dau.mil/

Defense Acquisition Guidebook - https://dag.dau.mil/

Milestone Document Identification Tool - https://dap.dau.mil/mdid/

ACQ 203 Course Schedule

Monday	Tuesday	Wednesday	Thursday	Friday
0800 - 1030 **Intro/Admin** DAU Story	0800 - 1100 Exercise 2.1 Acquisition System & Warm Up Exercises	0800 - 0815 Assessment Review	0800 - 0900 Capstone Teamwork	0800 - 0815 Assessment Review
		0815 - 0900 Introduce Capstone	0900 - 1100 Exercise 4.1 Reliability Issue	0815 - 1130 Exercise 2.1 Capstone Part 2 & 3 Acquisition Strategy Development, Presentation & Analysis
		0900 - 0930 Exercise 3.1 TPMs		
1030 - 1130 Exercise 1.1 IPT Leadership & Barriers	1100 - 1130 Exercise 2.2 Source Selection Planning	0930-1100 Exercise 3.2 Scheduling & Resourcing	1100 - 1200 Exercise 4.2 Contract Change	
		1100 - 1200 Exercise 3.3 Source Sel. Process		
1130 - 1230 Lunch	1130 - 1230 Lunch	1200 - 1300 Lunch	1200 - 1300 Lunch	1130 - 1230 Lunch
1230 - 1330 Exercise 1.2 Ethics & Acquisition	1230 - 1400 Exercise 2.2 Cont.	1300 - 1430 Exercise 3.4 Contractor Performance Analysis	1300 - 1400 Exercise 4.3 Problem Solving	1230 - 1400 Exercise 2.1 Capstone (Cont.)
	1400 - 1500 Exercise 2.3 Systems Eng.			
1330 - 1600 Exercise 1.3 Intro to Lifecycle/ Materiel Solution Analysis	1500 - 1600 Ex. 2.4 Test Planning	1430 - 1630 Exercise 3.5 Software Interoperability	1400 - 1600 Exercise 4.4 Supportability	1400 - 1430 Final Wrap Up / And Graduation
1600 - 1630 Daily Wrap Up (Homework)	**1600 - 1700** **Assessment (Homework)**	1630 - 1700 Daily Wrap Up	**1600 - 1700** **Assessment**	

Student Assessment

In the computer-based portion of the course (ACQ 202), you learned about the business, technical, and management processes involved in defense systems acquisition. In ACQ 203, you will work in an integrated product team environment to apply what you learned in the computer-based course to solve a variety of problems. Your performance in the classroom portion of the course will be evaluated on a pass/fail basis. You must achieve at least 80% mastery of the ACQ 203 learning objectives in order to pass the entire course. Should you not achieve the required 80% overall, you will be required to repeat ACQ 203. ACQ 203 classroom performance assessment is based on these factors.

1. Assessments (70 Points)

Content and Analysis Questions. On the second and fourth day of class, you will answer some multiple choice questions based on the material covered in ACQ 203. All assessments are individual efforts. You are encouraged to refer to your notes, lesson summaries, and other written references. Each assessment contains 15 questions and is worth 35 points

2. Participation (30 Points)

Class participation will be assessed through instructor observation of teamwork, leadership and discussions. You are expected to be in class on time, actively participate in group and class discussions, and rotate leadership responsibility among the members of your team (30 points). Behavior that could cause a student to lose participation points includes but is not limited to: tardiness, lack of attention, texting, sidebar conversations and disruption of class or team exercises and discussions.

3. Briefing

Each student is required to give a 5-10 minute briefing for their team. The briefing is a requirement for graduation but is not graded for points. This is an opportunity to develop and practice your briefing skills in a low threat environment.

4. Attendance

Attendance all 5 days is mandatory for graduation. Under special circumstances, such as a medical emergency, you may be excused from the course for up to two (2) hours **with the instructor's permission**. (Early flights on Friday are not considered a valid reason to miss class.)

Briefing Checklist

A briefing consists of the following:

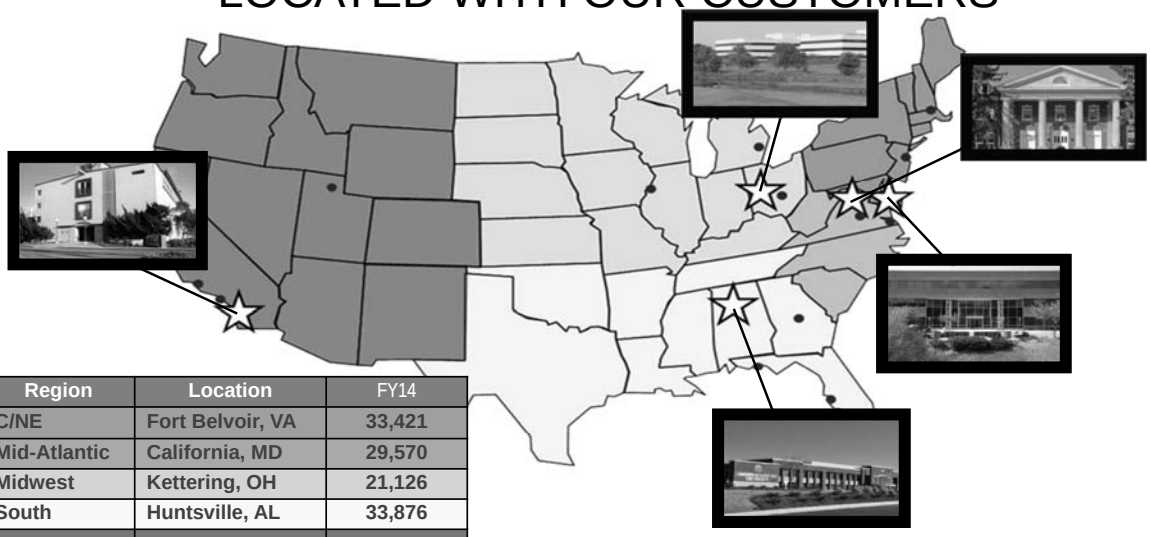
1. _____ **Briefer introduces self**
2. _____ **Briefer introduces the case**
3. _____ **Briefer demonstrates an understanding of the content by:**
   - **Explaining how your team built this product**
   - **Explaining your team's assumptions in putting the brief together**
   - **Explaining your team's rationale (i.e. how did we get here and why)**
4. _____ **Briefer accurately briefs their team's results**
   - **Briefer uses the correct terminology**
   - **Briefer is able to answer questions (at the 200 level based on prerequisite knowledge)**
5. _____ **Briefer uses clear and understandable visual aids**
6. _____ **Briefing is audible to the entire class**
7. _____ **Briefer has a logical Conclusion/recommendation based on their team's work**

Enabled to Support the Acquisition Workforce

10 USC Ch. 87 - Sec. 1746: "The Secretary of Defense … shall establish and maintain a defense acquisition university structure to provide for the professional educational development and training of the acquisition workforce."

DAU Mission: Provide a global learning environment to develop qualified acquisition, requirements and contingency professionals who deliver and sustain effective and affordable warfighting capabilities.

LOCATED WITH OUR CUSTOMERS



Region	Location	FY14
C/NE	Fort Belvoir, VA	33,421
Mid-Atlantic	California, MD	29,570
Midwest	Kettering, OH	21,126
South	Huntsville, AL	33,876
West	San Diego, CA	32,472
Total		150,465

We are part of the community, not just a place to take classes.

DAU: TRAINING COURSES…AND MORE

Formal & informal learning at the point of need

Training

Classroom & online DAWIA, Core Plus, & Executive
Targeted Training - Tailored organizational training
Rapid Deployment Training - On-site & online training on the latest AT&L policies

Continuous Learning

CL Modules - Online, self-paced learning modules
Conferences - DAU Acquisition Community Training Symposium, Hot Topic Forums

Knowledge Sharing

DAP - Online portal to Big A & HCI knowledge
ACC - DoD's online collaborative communities
Knowledge Repository and Acker Archives - Online connection to publications and DAU research resources

Mission Assistance

Consulting - Helping organizations solve complex acquisition problems
Team Training – Services Acquisition Workshops, MDAP event-driven training
Executive Coaching – For acquisition senior leaders

DAU'S iCATALOG

- Most current resource for information regarding DAU courses and the Certification & Core Plus Development Guides
- Accessible from the DAU home page (http://www.dau.mil) or directly at http://icatalog.dau.mil/

Program Management

Level I Certification

ACQ 101 Fundamentals of Systems Acquisition Management
25 hrs, online

ENG 101 Fundamentals of Systems Engineering
35 hrs, online

CLB 007 Cost Analysis

CLV 016 Introduction to Earned Value Management

1 Year Experience

Level II Certification

ACQ 201A Intermediate Systems Acquisition, Part A
25 hrs, online

ACQ 201B Intermediate Systems Acquisition, Part B
4.5 days classroom

PMT 251 Program Management Tools Course, Part I
20 hrs, online

PMT 257 Program Management Tools Course, Part II
4.5 days classroom

CON 121 Contract Planning
12 hrs, online

CON 124 Contract Execution
13 hrs, online

CON 127 Contract Management
10 hrs, online

IRM 101 Basic Information Systems Management
34 hrs, online

EVM 101 Fundamentals of Earned Value Management
34 hrs, online

2 Years Experience

Level III Certification

PMT 352A Program Management Office Course
22 hrs, online

PMT 352B Program Management Office Course
18.5 days classroom

BCF 103 Fundamentals of Business Financial Management
26 hours, online

SYS 202 Intermediate Systems Planning, Research, Development, & Engineering
9 hrs, online

LOG 103 Reliability, Availability, and Maintainability
32 hrs, online

ACQ 315 Understanding Industry
4.5 days classroom

EVM 263 Principles of Schedule Management (R)
3 days classroom

PMT-401 and PMT-402 meet statutory requirement for PEO/ACAT I/II PM & Deputy PM (10 USC 1735)

PMT 401 Program Manager's Course
10 weeks classroom

PMT 402 Executive PM Course
20 days classroom + online modules

- Potential ACAT I, IA, II, & III PMs, Dpty PMs
- PEOs & ACAT I, IA, II PMs & Deputy PMs

4 Years Experience

Earn College Credits For Your DAU Courses

DAU partners with more than 100 colleges & universities to obtain credit for DAU courses toward degrees and certificates

"Excel-erate" Your Master's Degree…
Through this program, partner universities are offering the Defense Acquisition Workforce credit toward masters degrees for DAWIA Level II and III certification.

Grantham University
UMC
Webster University
Bellevue University
Villanova University

Get College Credit Here

Impact: Saves time, tuition assistance dollars and out of pocket expenses

Providing Online Tools To Enhance Job Performance

DAP
Defense Acquisition Portal
A one-stop source for acquisition information and tools

AAP
Ask A Professor
Got an acquisition question? Go to the experts!

PM Toolkit
PM Toolkit
All the information a program manager could ever ask for in one convenient location

SAM
Service Acquisition Mall
All the tools and templates one needs to create performance-based service acquisition requirements

ACC
Acquisition Community Connection
Where the DoD and AT&L workforce meets to share knowledge

DAU MEDIA
Media
DAU Media
Video clips from senior leaders on acquisition topics

Acker
Acker Library and Knowledge Repository

BBP
Better Buying Power

DAG
DAG
Defense Acquisition Guidebook
The acquisition policy and discretionary best practice guide

https://dap.dau.mil/

Student Academic Policies & Information

Students should visit the Student Policies and Information page at www.dau.mil/training/Pages/studentinformation.aspx for information on:

- Student Standards of Conduct
- Violations of the Standards of Conduct
- Course Enrollment, Extensions, and Walk-ins
- Disenrollment, Dropping a Course, and Wait Lists
- Course Prerequisite/Pre-course Work Requirements
- Student Travel
- Student Assessment and Evaluation
- Student Attrition Codes
- Accommodating Students with Disabilities
- Transferring Students Between Career Fields (Programs) and from Other Institutions
- Test Reset Policy and Procedures
- Student Transcripts, Records Retention, and Disclosure of Student Academic Records (Privacy)
- Student Complaint/Grievance Procedures

DAU encourages students who have a concern or issue with the learning environment to discuss it with their instructor. Students who feel their issue is not resolved satisfactorily may go to the department chair/site manager or Regional Associate Dean for Academics.

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DAU Knowledge Repository

www.dau.mil/Library/

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PENNY EXERCISE

LESSON ASSIGNMENT SHEET

Lesson Number Exercise 1.1

Lesson Title Integrated Product Team (IPT) Leadership& Barriers

Lesson Time 1 hour

Terminal and Enabling Learning Objectives

TLO		**Determine how IPT leadership concepts can be used to overcome barriers to effective teamwork, based on real world experience.**
	ELO	Relate key tenets of IPPD to planning and executing an acquisition program.
	ELO	Identify the aids and barriers to successful IPT implementation.
	ELO	Identify the Supervisory, Participative and Team leadership styles.
	ELO	Describe how different leadership styles impact the effectiveness of an IPT.
	ELO	Identify the behaviors and characteristics of effective teams.

Assignments Review the following ACQ 202 CBT Lesson Summaries:

- Lesson 2.1, Integrated Product and Process Development
- Lesson 6.3, Leadership and Ethics

Estimated Student Preparation Time N/A

Assessment Class participation; oral presentation

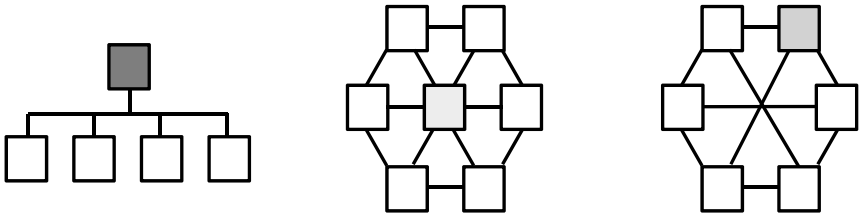
Related Lessons CBT Lesson 2.1, Integrated Product and Process Development
CBT Lesson 6.3, Leadership and Ethics

Self Study References

- *DoD Guide to Integrated Product and Process Development*, (Version 1.0), February 5, 1996.
- *Rules of the Road: A Guide for Leading Successful Integrated Product Teams*, Oct 1999. Available at http://www.defenselink.mil/nii/org/cio/pa/rulesoct1999.doc
- *DoD Integrated Product and Process Development Handbook*, August 1998.

IPT BARRIERS	IPT AIDS
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.

Leadership Styles



Supervisory	Participative	Team
Direct people	Involve people	Build trust and inspire teamwork
Explain decisions	Get input for decisions	Facilitate and support team decisions
Train individuals	Develop individual performance	Expand team capabilities
Manage one-on-one	Coordinate group effort	Create a team identity
Contain conflict	Resolve conflict	Make the most of team differences
React to change	Implement change	Foresee and influence change

From *Leading Teams, Mastering the New Role*, by Zenger, Musselwhite, Hurson and Perrin

Leadership and Critical Thinking

- Leaders who establish organizational trust create environment where critical thinking can be cultivated
  - Allows team members to experiment and adapt to change
- Driven by leaders characterized by humility & professional will
  - Humility – accurate self-view coupled with other-orientation vs self-focus
  - Professional will focus on long-term organizational goals – must be coupled with ethical behavior
- Leaders must create atmosphere of reasoned questioning and active, respectful dissent
  - Hierarchical control limits critical thought as team members are reluctant to question leadership
- Functional conflict can be healthy and used as a change agent to drive organizational growth
  - Opens team to new alternatives while considering all perspectives

Autocratic leadership subdues critical thinking

Consensus

A general agreement by <u>all</u> team members that they can live with and be <u>committed</u> to a particular course of action.

Synergy

When the output of a team is greater than the sum of the contributions of its individual members.

LESSON ASSIGNMENT SHEET

Lesson Number Exercise 1.2

Lesson Title Ethics and Acquisition

Lesson Time 1 hour

Terminal and Enabling Learning Objectives

TLO		**Resolve an acquisition-related dilemma by prioritizing ethical values and considering how choices impact the welfare of others.**
	ELO	Identify the characteristics of a "successful" defense acquisition program from a variety of perspectives.
	ELO	Identify core ethical values critical to decision making in the acquisition environment.
	ELO	Identify the steps of the Principled Decision Making Model
	ELO	Resolve an ethical dilemma by applying the steps of the Principled Decision Making Model.

Assignments Review the following ACQ 202 CBT Lesson Summary:

- Lesson 6.3, Leadership and Ethics

Estimated Student Preparation Time N/A

Assessment Class participation

Related Lessons CBT Lesson 6.3. Leadership and Ethics

Self Study References N/A

Exercise 1.2 Successful Acquisition Program

What is a successful defense acquisition program?

It depends upon your point of view:

_____ A successful program delivers a system that meets the user's technical performance requirements on time and within budget.

_____ A successful program is profitable; it provides a positive cash flow and return on investment.

_____ A successful program provides capability in a system that is available, effective, and easy to operate in wartime and peacetime.

_____ A successful program balances social, environmental and defense needs. It provides a fair distribution of defense dollars by state.

Whose perspectives are indicated above? Fill in the blanks.

Principled Decision Making Model

- Consider the welfare of all stakeholders.
- Give precedence to ethical values over non-ethical values.
- Prioritize based on what will bring the most good and least harm to others.

Ethical Values

- Trustworthiness
- Respect
- Responsibility
- Justice / Fairness
- Caring
- Civic Virtue / Citizenship

Non-Ethical Values

- Profit Motive
- Career Progression
- Power
- Position

Case 1.2, An Ethics Dilemma

Read the following case and discuss the three questions with your team:

Brigadier General Burt Goodguy is the Program Executive Officer (PEO) for five military programs. Tomorrow he is to testify before the House Armed Services Committee (HASC) regarding a very sophisticated and expensive weapons system considered a very high priority by his service secretary. The prime contractor is Mogul Systems, located in the district of Rep. Allen, chairman of the HASC.

The system is in trouble because Congress is desperately looking to make large cuts in the defense budget, and the program is almost one year behind schedule. In addition, several significant technical problems were uncovered in the most recent tests. Several members of Congress have publicly advocated canceling the system before it goes into full production. Mogul insists it has solved the problems and is confident that the system will pass its next test with flying colors. Mogul asserts it can go into full production within nine months. The Secretary of Defense has thus far been strongly supportive of the system in his public statements, but some think he is privately wavering for political reasons.

Col. Wantit, Program Manager for the system, briefs BGen. Goodguy and tells him that he is not sure that Mogul has solved the problems yet. BGen. Goodguy grimaces at this news and says sarcastically, “Can’t you bring me good news? You aren’t helping the cause, you know.”

Col. Wantit recently heard disturbing rumors, which he has not yet tried to verify, that the chief scientist on the program is seriously ill (possibly with cancer) and that several top engineers are about to quit. If either of the rumors is true, the likelihood that Mogul will solve its problems before the next test is much less likely. However, he still believes the problems are temporary. Since the information is shaky and so potentially volatile, Col. Wantit decides not to tell BGen. Goodguy about the rumors for fear that he might have to mention it to Congress, and some politicians and the press would blow the program.

1. Who are the stakeholders in his decision?

2. What ethical values are involved in Col. Wantit’s decision to withhold his information about the rumors?

3. What would you have done in his place?

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Case 1.2, An Ethics Dilemma (continued)

An hour after briefing BGen. Goodguy, Col. Wantit receives a call from Barbara Leake, a top manager at Mogul who has known Col. Wantit for 10 years.

Leake: *George, it's Barbara Leake. How are things going for you?*

Wantit: *Things are pretty hectic around here, as usual. How about you?*

Leake: *"Well, this isn't for publication, but I wanted you to know I'm going to be leaving Mogul. If you know of any appropriate openings, let me know."*

Wantit: *"I've got to know more. Is the program in any way endangered? Are there problems I should know about?"*

Leake: *"Probably, but you simply can't use this yet: it will be traced to me. Even if you sniff around they will suspect me, and it would kill any chance I have to land another job. I've already told you too much, and it really isn't a big thing. Really. I'll tell you the whole story if you hold it confidential for a week or so."*

Wantit: *"I can't promise that. But I need to know, and you need to tell me. I'll protect you as a source as best I can."*

Leake: *"I'm sorry, I just can't risk it, but you'll know whatever you need to know in a few days, I imagine. It's just not that serious. Look, I've got to go to a meeting now; goodbye…"*

1. Did Col. Wantit handle this properly?

2. Who are the major stakeholders?

3. What ethical values are involved?

4. What would you have done in Col. Wantit's position?

5. What, if anything, should Col. Wantit tell BGen. Goodguy?

6. Should BGen. Goodguy want to know about this and similar information? Would you?

7. If BGen. Goodguy wanted his people to tell them everything that might be relevant to a program, what could he do to increase the likelihood?

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LESSON ASSIGNMENT SHEET

Lesson Number Exercise 1.3

Lesson Title Materiel Solution Analysis

Lesson Time 2.5 hours

Terminal and Enabling Learning Objectives

TLO		**Evaluate alternative approaches to meet a needed capability based on affordability, schedule and technical considerations**
	ELO	Given a user's requirement and selected concept, select an appropriate approach from the perspective of the system developer, to meet the requirement.
	ELO	Identify the three major dimensions of program risk used to analyze technical approaches during the Materiel Solution Analysis Phase (cost, schedule and performance)
	ELO	Identify the concept of affordability goals in relation to an acquisition program.
	ELO	Relate the concept of affordability goals to the planning of an acquisition program.
	ELO	Working in a student-led IPT, demonstrate the behaviors and characteristics of an effective team.

Assignments Review the following ACQ 202 CBT Lesson Summaries:

- Lesson 1.1, Considering the Costs
- Lesson 1.2, Selecting the Best Approach
- Lesson 2.2, Developing the Acquisition Strategy

Estimated Student Preparation Time None

Assessment Class participation; oral presentation

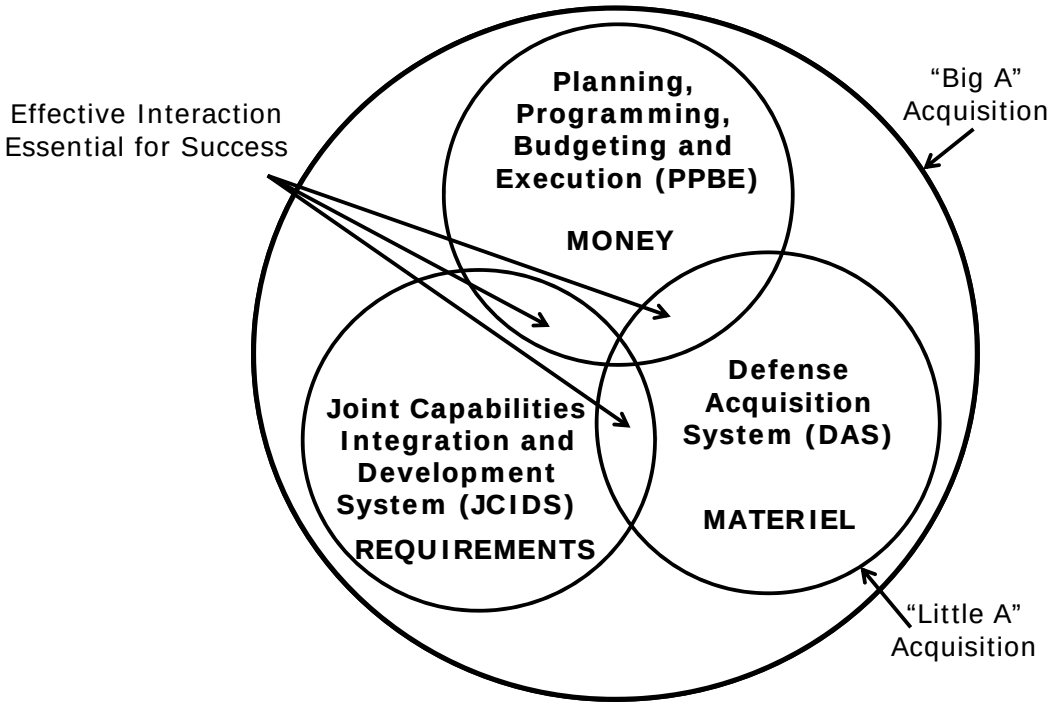
Related Lessons

CBT Lesson 1.1, Considering the Costs
CBT Lesson 1.2, Selecting the Best Approach
Classroom Exercise 2.1, Acquisition Strategy

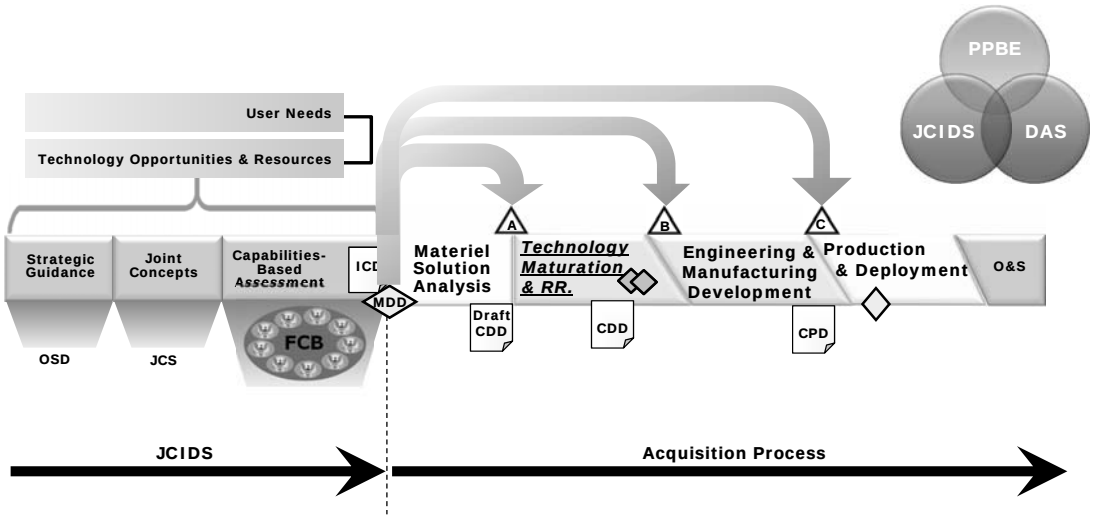
Self Study References

- DoDD 5000.01, *The Defense Acquisition System*, 12 May 2003
- DoDI 5000.02, *Operation of the Defense Acquisition System*, 8 *November* 2013
- *Defense Acquisition Guidebook*

DoD Decision Support Systems



The Defense Acquisition Management System Relationship to JCIDS



"If the Materiel Development Decision is approved, the MDA will designate the lead DoD Component; determine the acquisition phase of entry; and identify the initial review milestone."

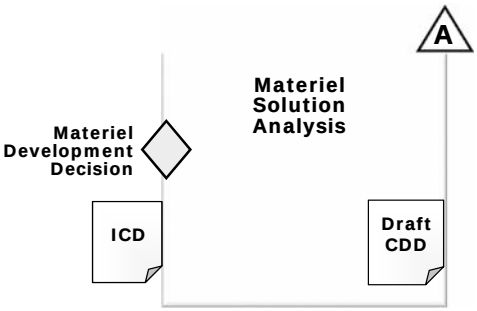
DoDI 5000.02 and Defense Acquisition Guidebook (DAG)

Guidebook is on line at
https://dag.dau.mil

- **DoDI 5000.02 7 January 2015**
  - Incorporates several DTMs and BBPI
  - Provides mandatory guidance for the operation of the Defense Acquisition Management System
  - 6 acquisition models with emphasis on tailoring
  - Rapid acquisition model for urgent needs
- **DAG**
  - Provides non-mandatory guidance on best practices, lessons learned and expectations
  - Guidebook focuses on processes ("how to")
  - Designed for electronic use
  - Organized by functional area and acquisition phase
  - Built-in links

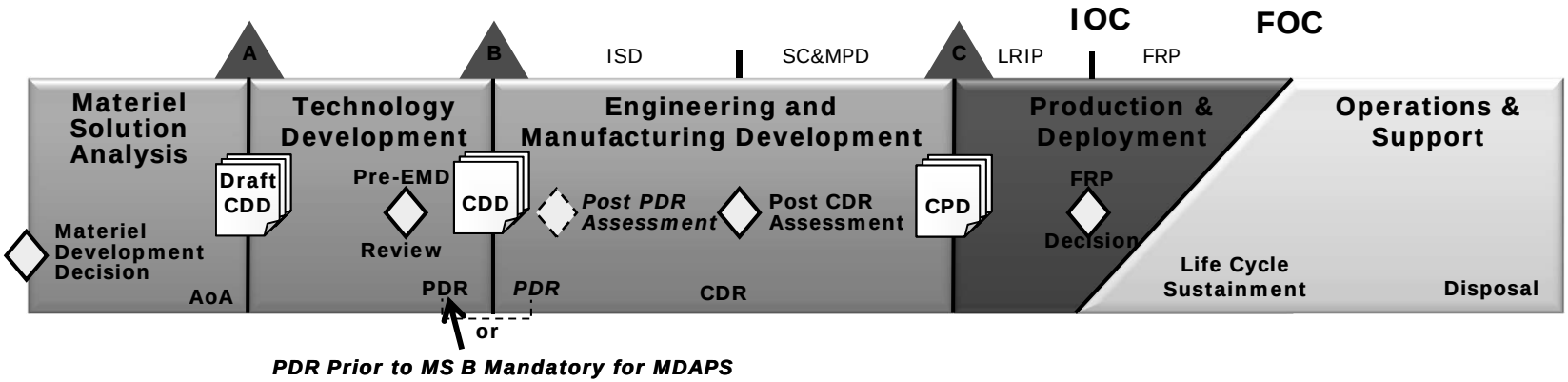
Materiel Solution Analysis

PURPOSE: to conduct the analysis and other activities needed to choose the concept for the product that will be acquired

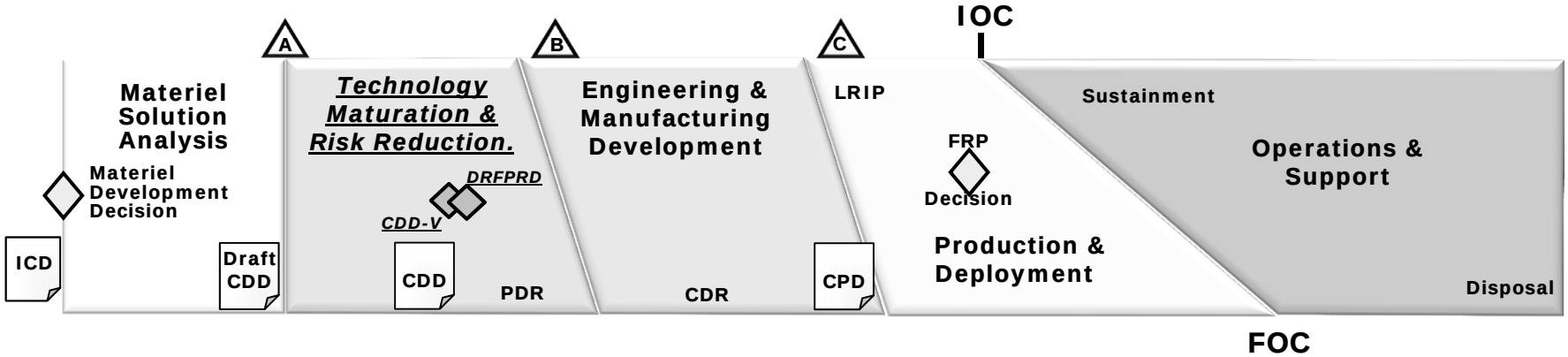


- **ENTER:** Approved ICD, study guidance for conducting the AoA and an ***approved AoA plan***. AoA study guidance for MDAPs and AoA plan approval will be provided by CAPE.
- **ACTIVITIES:** ***Establish PM & PMO,*** Conduct AoA, user writes draft CDD, develop initial:
  - ***Acquisition Strategy***
  - ***Test & Evaluation Master Plan (TEMP)***
  - Systems Engineering Plan (SEP)
  - ***Life Cycle Sustainment Plan (LCSP)***
  - ***Cyber Security Strategy***
  - Other Program Documentation as Required
- **GUIDED BY:** ICD and AoA Plan
- **EXIT:** Completed the necessary analysis and activities to support a decision to proceed to the next decision point and desired phase in the acquisition process.

2008



2015 (Model 1: Hardware Intensive Program)

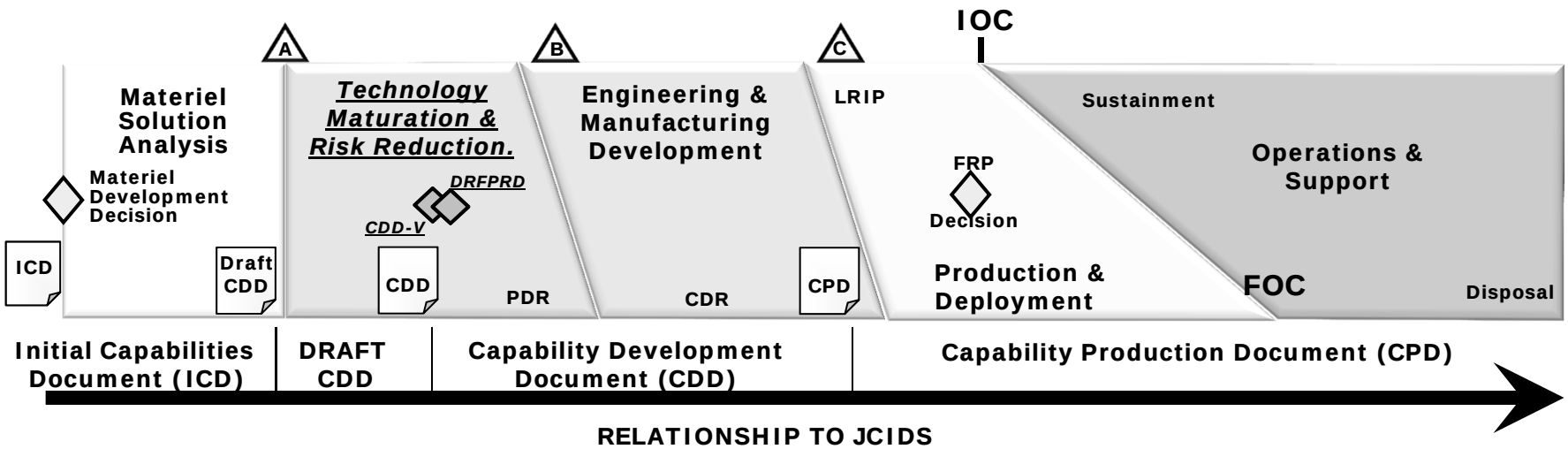


- 5 additional models including hybrid hardware and software models with emphasis on tailoring
- Annual high level Configuration Steering Boards (CSBs) to address cost/performance trades
- Initial Acquisition Strategy, Cyber Security Strategy, TEMP, SEP and LCSP all due at Milestone A
- Independent Logistics Assessments (ILAs) before each decision point starting at Milestone B
- Program Office established and PM assigned during Materiel Solution Analysis phase
- Emphasis on thoughtful planning vs. compliance

The Defense Acquisition Management System

- The Materiel Development Decision precedes entry into any phase of the acquisition management system
- Entrance Criteria met before entering phase
- Evolutionary Acquisition or Single Step to Full Capability

Model 1: Hardware Intensive Program



▪ PDR: Preliminary Design Review ▪ CDR: Critical Design Review ▪ CDD-V: CDD Validation	▪ LRIP: Low Rate Initial Production ▪ FRP: Full Rate Production ▪ DRFPRD: Development Request For Proposals Release Decision	▪ IOC: Initial Operational Capability ▪ FOC: Full Operational Capability

Exercise 1.3 Materiel Solution Analysis

This lesson is divided into two activities, A and B. Everyone should read both activities. However, half of the student teams will be assigned Activity A, and the other half will be assigned Activity B.

Activity A – Enhanced Survivability

Scenario

Firebird unmanned aerial vehicles (UAVs) are nearing the end of fielding, and the Services have used them extensively in a number of conflicts. When this first increment of the Firebird was in development, a second increment was planned to provide additional survivability from current and projected threats from heat seeking shoulder-launched missiles.

Although military operators are extremely pleased with Firebird's combat capabilities, they are unhappy with its poor availability due to higher-than-anticipated combat losses. Most of these losses have been from heat-seeking shoulder-launched missiles. Records show that several air vehicles were shot down by these missiles over the last few years. The losses have created a serious air vehicle shortage, leading to unacceptably low operational availability.

The second increment is now in the early part of the Materiel Solution Analysis Phase. This increment will significantly increase Firebird's survivability against the shoulder-launched missile threat. This increment and a future 3rd increment are supported by a time-phased requirement, originally documented in the approved Firebird I Capability Development Document (CDD).

This increment of the program, dubbed "Firebird II," is now being planned to meet the new survivability requirement. This activity is supported by the Acquisition Strategy created in Firebird I's development. The users have drafted the following requirement language:

DRAFT REQUIREMENT FOR FIREBIRD SURVIVABILITY ENHANCEMENT

Capabilities required:

1. Firebird II will incorporate improved survivability measures such that the probability of survivability during a single engagement by a shoulder-launched heat-seeking missile is greater than or equal to 90%. This is a Key Performance Parameter (KPP).

2. Firebird II must meet all unamended requirements in the CDD for the first increment.

Using the draft requirement language as a guide, three alternative approaches for enhancing survivability have been studied by Mitronix, a Federally Funded Research and Development Center (FFRDC). Their report is provided below.

FIREBIRD II UAV
ALTERNATIVE APPROACHES FOR INCREASING SURVIVABILITY

Approach 1: Modify Firebird to fly high enough to avoid shoulder-launched missiles.

Research shows that existing shoulder-launched missiles have an effective ceiling of 15,000 ft., but intelligence sources indicate that near-term improvements are expected to increase the ceiling to 18,000 feet. Analysis indicates that increasing Firebird's ceiling to 20,000 ft. when loitering in the threat zone will meet the new survivability requirement.

Increasing Firebird's operational altitude will require some changes to existing control software in both the vehicle and ground station. The software effort should have minimal impact on the overall time and cost for the upgrade and is considered low risk. Higher altitudes will necessitate a modified or new propulsion system, redesign of fuel systems, and upgrades to vehicle sensor packages. Technology in these areas is fairly mature resulting in low hardware risk. Research and development (R&D) costs are expected to be $140M (RDT&E appropriation) due to the extensive testing and work required to design all the modifications. Production costs are estimated at $285M (Procurement appropriation). Operations and Support (O&S - a combination of O&M and MILPERS appropriations) costs with this upgrade are estimated at $32.5M per year. Disposal cost is estimated to be $65M. It is expected this approach will take 34 months from program initiation to initial operational capability (IOC). However, if new engine technology now in advanced development does not mature as planned, IOC would end up slipping to 36 months.

Approach 2: Add on-board countermeasures (flares) and pre-programmed evasive maneuvering to avoid heat-seeking targeting systems of incoming missiles.

Flares are missile decoy devices that are released from air vehicles when a heat-seeking threat is detected. When combined with evasive maneuvering, flares are effective survivability enhancers that have been successfully used for years by manned aircraft. Adding flares and evasive maneuvering would allow Firebird to meet the new survivability requirement without increasing altitude.

This approach requires integration of new control capabilities into both the ground control console and the air vehicle. Also, the addition of missile sensing and evasive maneuvering capabilities necessitates writing and rigorously testing a large amount of new software. Missile sensing technology is widely available and considered a low risk. Some of the existing flight control software will be re-usable for the evasive maneuvering. Past experience shows that flight control software complexity is often underestimated. Therefore, this approach entails moderate software risk. Required integration of both the mechanical operation and the physical characteristics (size, weight, attachments, etc.) of new countermeasures into the air vehicle is considered moderate risk. R&D costs are estimated to be $150M (RDT&E). Most of those costs are due to the extensive software effort required. Production costs are expected to be $300M (Procurement). Operations and support costs with this upgrade are estimated at $28.75M (O&S) per year. Disposal cost is estimated to be $58M

This approach will take 30 months from initiation to IOC. There is a relatively low risk that the flight control software will not be reusable, which would add three months and $4M (RDT&E) to this approach.

Approach 3: Reduce the heat signature of the vehicle.

Reducing the heat signature of air vehicles to increase survivability has a proven track record in numerous existing aircraft. Heat signature reduction techniques and materials in use are relatively mature and cost-effective. If Firebird's heat signature can be reduced sufficiently it will meet the new survivability requirement.

This option requires significant hardware redesign of portions of the airframe structure, mostly in the engine exhaust area. While the technology is mature it is expected that current techniques and materials cannot reduce Firebird's signature sufficiently to meet the requirement. Also, characteristics of Firebird, such as low speed, small size, and the need for short takeoffs and landings, will make this a high-risk hardware redesign effort. Extensive testing will be required to prove performance and reliability, but much of the data should be available from the labs and/or modeling and simulation. Software risk is low since this approach will require only minimal changes to existing software code. R&D costs are expected to be $160M (RDT&E) due in large part to the redesign challenges. Production costs are estimated at $320M (Procurement). Most of those costs are driven by the anticipated need for expensive materials and unique manufacturing processes. Operations and support costs with this upgrade are estimated at $26.25M (O&S) per year. Disposal cost is estimated to be $53M.

This approach is projected to take 32 months from initiation to IOC. There is a moderate risk that a new propulsion system or major redesign of the existing system will be required. If that happens, both R&D and production costs will increase 30% and the schedule will stretch 6 months.

For teams assigned Activity A (Increased Survivability), here is your tasking:

1. Choose a team leader/briefer. Use the information in the Mitronix report to build a matrix that shows the cost, schedule and technical characteristics of each of the three approaches.

2. Preliminary discussions among the PM, PEO, service officials and other stakeholders indicate that money and time are tight, as usual, but the user has a valid need for the survivability enhancement. Taking these discussions into account, along with an affordability analysis and the urgency of the requirement, the PM has provided the following guidance:

   "This survivability enhancement should not take longer than 36 months from initiation to IOC, the R&D affordability goal is $160M (RDT&E), and the Production affordability goal is $320M (Procurement). O&S costs should be no more than $32.5M per year. Total Life Cycle Cost (LCC) should not exceed $1.19B. Also, cost, schedule and technical risks should be weighted equally when considering alternative approaches. Assume a 20-year operational life for the Firebird II UAVs."

Your team has been asked to help assess technology that is currently under development to determine applicability to the Firebird II. Assuming the draft requirement language will be approved as written, and considering the PM's guidance:

- Use your matrix to help you rank each of the three approaches based on the overall risk of meeting the new requirement within schedule and affordability goals
- Discuss and list any assumptions your group feels are necessary.

For this academic exercise, do not create new approaches or combine elements of different approaches.

3. Prepare a 10-minute briefing to the class that:
   - Explains how you built your matrix.
   - Lists and explains any assumptions made by your team.
   - Lists and explains the rationale behind your approach rankings.

Alternative	HW Risk	SW Risk	RDTE $	Proc $	O&S $	LCC	Mths to IOC
PM Guidance							

Activity B - Increased Range

Scenario

The first increment of Firebird brought a much-needed capability to the operational forces. When this first increment of the Firebird was in development, it was recognized that additional range would be required in the future.

The second increment is now in early part of the Materiel Solution Analysis Phase. The user has found new and innovative uses for Firebird and, simultaneously, the military is losing a critical aviation mission asset much earlier than expected due to increases in operational tempo, budget cuts, and consolidation. Loss of this asset will create a gap in reconnaissance coverage within four years. All the Services want to fill the resulting gap by increasing Firebird's range from 100 to 250 KM (threshold)/300 KM (objective). As part of the acquisition process, the Services are planning to execute the next increment to increase Firebird's range. This increment and a future 3rd increment are supported by a time-phased requirement, originally documented in the approved Firebird I Capabilities Development Document (CDD).

This increment of the program, dubbed "Firebird II," is now being planned to meet this new requirement. This activity is supported by the Acquisition Strategy created in Firebird I's development. The users have drafted the following requirement language:

DRAFT REQUIREMENT FOR FIREBIRD II
INCREASED RANGE

Capabilities required:

1. Firebird II will have a range of 250/300 KM (threshold/objective). This is a Key Performance Parameter (KPP).

2. Firebird II must meet all unamended requirements in the CDD for the first increment.

Using the draft requirement language as a guide, three alternative approaches for increasing range have been studied by Mitronix, a Federally Funded Research and Development Center (FFRDC). Their report is provided below.

FIREBIRD II UAV
ALTERNATIVE APPROACHES FOR INCREASING RANGE

Approach 1: Use new propulsion system to provide more range

Any new propulsion system must be significantly more efficient to achieve the additional range. There are several possible commercial and Non-Developmental Item (NDI) solutions, but none can be easily integrated into the current air vehicle configuration due to compromises made with non-standard interfaces in the original design. A new engine will need extensive testing, both in the lab and in the air, but some of the data needed should be available through modeling and simulation, depending on the design chosen. All of these factors lead to moderate hardware risk.

Some software will need to be rewritten for control of the propulsion system, but that should be a fairly straightforward, low risk effort. R&D costs are estimated at $180M (RDT&E). Production costs should be $410M (Procurement). Operations and Support (O&S - a combination of O&M and MILPERS appropriations) costs with this upgrade are estimated at $35M per year. Disposal cost is estimated at $70M.

This effort should take 34 months from initiation to IOC. There is a moderate risk that the integration of the new engine will be more difficult than planned, requiring an additional $20M (RDT&E) and 3 more months to make IOC.

Approach 2: Increase wing span and fuel capacity of air vehicle

This approach will require redesign of a significant portion of the airframe. Increasing the range to 250-300KM will require nearly twice as much fuel capacity. Lengthening the wing span will provide room for more fuel, but will also add weight. Extensive flight testing will be necessary to ensure the new design meets all operational and safety requirements. Some of the required flight test data should be obtained from wind tunnel tests or modeling and simulation which will reduce the cost and time required for actual flight tests. Design techniques and production processes that will be used for this approach are relatively mature. Overall hardware risk is considered moderate. Flight control software will need to be modified, and portions may need to be completely rewritten. Past experience on Firebird indicates that flight control software complexity is often underestimated. For this approach, it is expected that very little software will be re-usable. The software risk for this approach is expected to be high.

R&D costs are estimated at $200M (RDT&E). Most of that cost is due to the extensive software effort and risk mitigation required. Production costs are estimated at $350M (Procurement). Operations and support costs with this upgrade are estimated at $38.75M (O&S) per year. Disposal cost is estimated at $78M. This effort will take 34 months from initiation to IOC. There is a low risk that additional flight testing will be required, adding $30M RDT&E and 2 months to the schedule.

Approach 3: Streamline design and decrease weight of air vehicle

This approach will require a significant redesign of the air vehicle. The degree of technical difficulty in reducing weight will largely depend on how well the original designers incorporated weight-reduction elements in the current Firebird. It is expected that weight reduction will need to be supplemented with a more streamlined aerodynamic design, further complicating the

development. Anytime this is attempted, difficult technical tradeoffs must be made. These factors, combined with the expected need for special materials and production processes, indicate high hardware risk for this approach. In addition to the air vehicle redesign, the flight control software must be modified. However, much of the software should be re-usable, and the software effort can be minimized through computer-aided vehicle design, so the overall software risk for this approach is considered moderate.

R&D costs are estimated at $220M (RDT&E), production costs at $395M (Procurement). Operations and support costs with this upgrade are estimated at $30M (O&S) per year. Disposal cost is estimated at $60M. This effort will take 36 months from initiation to IOC.

For teams assigned Activity B (Increased Range), here is your tasking:

1. Choose a team leader/briefer. Use the information in the Mitronix report to build a matrix that shows cost, schedule and technical risks of each of the three approaches.

2. Preliminary discussions among the PM, PEO, service officials and other stakeholders indicate that money and time are tight, as usual, but the user has a valid need for the additional range. Taking these discussions into account, along with an affordability analysis and the urgency of the requirement, the PM provides the following guidance:

   > "This range enhancement should not take longer than 36 months from initiation to IOC, the R&D affordability goal is $220M (RDT&E), and the Production affordability goal is $420M (Procurement). O&S costs should be no more than $35M (O&S) per year. Total Life Cycle Cost (LCC) should not exceed $1.41B. Also, cost, schedule and technical performance should be weighted equally when considering alternative approaches. Assume a 20-year operational life for the Firebird II UAVs".

   Your team has been asked to help assess technology currently under development to determine applicability to the Firebird II. Assuming the draft requirement language will be approved as written, and considering the PM's guidance:

   - Use your matrix to help you rank each of the three approaches based on the overall risk of meeting the new requirement.
   - Discuss and list any additional assumptions your group feels are necessary.

   For this academic exercise, do not create new approaches or combine elements of different approaches.

3. Prepare a 10-minute briefing to the class that:
   - Explains how you built your matrix.
   - Lists and explains any assumptions made by your team.
   - Lists and explains the rationale behind your approach rankings.

DRAFT

FIREBIRD II UNMANNED AERIAL VEHICLE (UAV) SYSTEM

CAPABILITY DEVELOPMENT DOCUMENT (CDD)

(Excerpt of Performance Requirements)

UNCLASSIFIED DRAFT

CAPABILITY DEVELOPMENT DOCUMENT FOR FIREBIRD II UNMANNED AERIAL VEHICLE (UAV) SYSTEM

Increment: II
ACAT: II
Validation Authority: JROC
Approval Authority: Army
Milestone Decision Authority: Assistant Secretary of the Army (Acquisition, Logistics and Technology)
Joint Staffing Designator: JCB Interest
Prepared for Milestone B Decision

[Subparagraphs in *italics* are omitted because they are not applicable for academic purposes]

Executive Summary *[Simplified for academic purposes]*: Firebird II is the second increment to the baseline Firebird in response to expected but initially undefined requirements to increase range and improve survivability. This increment will be accomplished as part of the Firebird's evolutionary acquisition strategy.

Revision History: Omitted: Not required for classroom activities.
Table of Contents: Omitted: Not required for classroom activities.
Points of Contact: Omitted: Not required for classroom activities.

1. Capability Discussion.

a. Firebird losses due to shoulder-launched missiles are much higher than planned, exceeding the ability of support systems to sustain the system. This has resulted in unacceptably low operational availability and unplanned costs.

b. The initial increment of Firebird does not have sufficient range to conduct reconnaissance operations out to 250 KM. This range is needed due to the earlier-than-anticipated loss of another military asset (classified), which will create a gap in coverage.

2. Analysis Summary. *[Simplified for academic purposes]* The AoA conducted during Materiel Solution Analysis identified several technical approaches that could achieve the desired improvement in range and survivability. The Acquisition Strategy recommended that a Technology Maturation and Risk Reduction phase be used to further develop these approaches and reduce the risk to an acceptable level.

3. Concept of Operations Summary. *[Simplified for academic purposes]* The intent is to field a joint UAV, Firebird II, with improved Range and Survivability over the current Firebird. The system will perform the same general reconnaissance, surveillance and target acquisition

missions as well as the capability to detect, track and launch a weapon to destroy a moving vehicle or fixed target.

4. Threat Summary.

The system will be directed against lightly armored, mobile ground targets, such as Scud missile launchers, SA-9 Surface-to-Air Missiles and other mobile artillery weapons. It will also be used against small lightly armored water-borne targets (e.g., gunboats).

5. Program Summary. This is the second increment in the Firebird program.

a. The first increment provided a system capable of locating and destroying lightly armored enemy ground targets from an unmanned aerial vehicle (UAV) when directed from the ground and/or naval ships by friendly forces during daylight hours. Each system consists of four recoverable unmanned air vehicles and a ground station equipment package. System is used by all U.S. services.

b. This second increment will address range and survivability improvements.

c. The third increment will address improved loiter time.

6. System Capabilities Required for the Current Increment

a. The UAV shall be capable of being deployed from a mobile launcher unit. The launcher shall be capable of propelling the aerial vehicle from a standing stop to airborne within a distance of 25 (objective) to 30 (threshold) feet.

b. The UAV shall be recoverable, with or without munitions on board, onto an unimproved landing surface (threshold). It shall be capable of being re-used in subsequent missions.

c. Minimum range of the UAV shall be 250/300 km (threshold)/(objective).

d. The UAV shall have the ability to cruise at speeds between 40 and 80 kilometers per hour (KPH). Once within the patrol area, the system should be able to loiter for at least three (3) hours (threshold) in a search and destroy mode. The system, with its munitions mounted on the UAV, shall have an explosive force comparable to 200 (threshold) to 500 (objective) lbs. of TNT, with the system having a CEP[1] of 10 (threshold)/5 (objective) meters.

e. The UAV will have a single optical target acquisition system (threshold) for daytime operations.

f. The UAV shall be capable of transmitting video images in real time, throughout the mission, to a ground control unit beyond the line of sight (LOS), other military airborne

[1] CEP, the circular error of probability, refers to the radius around the target within which the munitions must fall 50% of the time.

surveillance and targeting units, and receiving and responding to avionics commands from the ground control terminal (threshold).

g. The UAV shall be able to link and exchange data with the DoDIN and other systems as defined in Annex A, Net-Ready KPP Products.

h. Firebird II will incorporate improved survivability measures such that the probability of survivability during a single engagement by a shoulder-launched heat-seeking missile is greater than or equal to 90%.

i. Materiel Reliability - Mean Time between Critical Failure (MTBCF) shall be no less than 150 (threshold)/200 (objective) hours.

j. Mean Time to Repair (MTTR) shall not exceed 3 (threshold)/2.5 (objective) hours.

Table 4.1 Key Performance Parameter Table

Tier 1 & Tier 2 JCAs	Key Performance Parameter	Development Threshold	Development Objective
Omitted: Not required for classroom activities	Range	250 Km	300 Km
	Survivability : Expected survival rate when engaged by shoulder-launched heat-seeking missiles	The probability of survivability during a single engagement by a shoulder-launched heat-seeking missile shall be greater than or equal to 90%.	Same
	Loiter	3 hours	Same
	Explosive Force	200 lbs TNT	500 lbs TNT
	Accuracy	10 Meter CEP[1]	5 Meters CEP[1]
	Net-Ready	System supports military ops, is entered on the network and effectively exchanges information	Same
	Sustainment	Materiel Availability (A_m) of .80	.85
	Training	(not required for classroom activities)	
	Energy	(not required for classroom activities)	
	Force Protection	Not applicable: Firebird II is not a manned system	
	Survivability	Not applicable: Firebird II is not a manned system	

Table 4.2 Key System Attributes Table

Additional Performance Attribute	Development Threshold	Development Objective
Mobile Launch Distance	30 Feet	25 feet
Recovery Conditions with Munitions	Unimproved landing surface	Same
Cruising Speed	40 KPH	80 KPH
Target Acquisition System	One optical system suitable for daytime operations	Same
Materiel Reliability	Mean Time between Critical Failure (MTBCF) 150 hours	200 hours

Mean Time to Repair (MTTR)	3 hours	2.5 hours
Operations and Support Costs	*Omitted: Not required for class*	

7. Family of Systems and Systems of Systems Synchronization. – Omitted: Not required for classroom activities.

8. Information Technology and National Security Systems Supportability. - Omitted: Not required for classroom activities.

9. Intelligence Supportability - Omitted: Not required for classroom activities.

10. Electromagnetic Environmental Effects (E3) and Spectrum Supportability – Omitted: Not required for classroom activities.

11. Assets Required to Achieve Initial Operational Capability (IOC) - Omitted: Not required for classroom activities.

12. Schedule and IOC and Full Operational Capability (FOC) Definitions.

The program should take no longer than 48 months (threshold)/42 months (objective) from initiation to IOC. IOC is defined as two combat-ready systems (8 UAVs and two ground stations) with properly trained and equipped personnel. FOC is 400 Firebird air vehicles retrofitted and 100 ground stations modified.

13. Other DOTMLPF and Policy Considerations *[Simplified for academic purposes]*

Logistics and Facilities Considerations

a. Maintenance Planning: Maintenance shall be limited to two levels: operator maintenance and depot repair. Repair parts shall be commercially available to the maximum extent practical.

b. Ground Stations: The ground station shall consist of a launcher, a ground control unit, commercially available hand tools, and associated documentation. The ground control unit shall include built-in-test equipment to verify flight control circuitry and it shall contain simulation flight control software to be used as a training tool.

c. Human Systems Integration: The system shall be capable of set up, operation, and tear down by a crew of no more than four (threshold) or three (objective) trained personnel.

d. Transportation and Basing: The system shall be capable of being moved within the theater by aircraft (CH-47 and larger) or vehicle (2 1/2 ton truck and larger).

14. Other System Attributes – Omitted: Not required for classroom activities.

15. Program Affordability. *[Simplified for academic purposes]*

RDT&E	Objective	$325M	Threshold	$350M
Procurement	Objective	$650M	Threshold	$720M

(Dollars are Then Year)

Mandatory Appendices.

Appendix A. Net-Ready KPP Products (Not required for classroom activities)

Appendix B. References (Not required for classroom activities)

Appendix C. Acronyms (Not required for classroom activities)

d. Acquisition Process Decision Points and Phase Content. The procedures in subparagraphs 5d(1) through 5d(14) are general and are applicable to the acquisition program models previously described and to variations in them. Tailoring is always appropriate when it will produce a more efficient and effective acquisition approach for the specific product. Non-MDAP and non-MAIS programs will use analogous DoD Component processes. Additional or modified procedures applicable to Information Technology and to Defense Business System programs are described in Enclosures 11 and 12 of this instruction, respectively, and procedures applicable to urgent needs are described in Enclosure 13.

(1) Materiel Development Decision

(a) The Materiel Development Decision is based on a validated initial requirements document (an ICD or equivalent requirements document) and the completion of the Analysis of Alternatives (AoA) Study Guidance and the AoA Study Plan. This decision directs execution of the AoA, and authorizes the DoD Component to conduct the Materiel Solution Analysis Phase. This decision point is the entry point into the acquisition process for all defense acquisition products; however, an "acquisition program" is not formally initiated (with the accompanying statutory requirements) until Milestone B, or at Milestone C for those programs that enter directly at Milestone C. DoD Components may have conducted enough analysis to support preliminary conclusions about the desired product at this point. If so, that analysis may be used by the MDA to narrow the range of alternatives. If not, requirements are likely to be less well-defined or firm, and a wider range of alternatives will need to be considered.

(b) At the Materiel Development Decision, the DCAPE, (or DoD Component equivalent) will present the AoA Study Guidance, and the AoA lead organization will present the AoA Study Plan. In addition, the Component will provide the plan to staff and fund the actions that will precede the next decision point (usually Milestone A) including, where appropriate, competitive concept definition studies by industry.

(c) If the Materiel Development Decision is approved, the MDA will designate the lead DoD Component; determine the acquisition phase of entry; and identify the initial review milestone, usually, but not always, a specific milestone as described in one of the program models. MDA decisions will be documented in an ADM. The approved AoA Study Guidance and AoA Study Plan will be attached to the ADM.

(2) Materiel Solution Analysis Phase

(a) Purpose. The purpose of this phase is to conduct the analysis and other activities needed to choose the concept for the product that will be acquired, to begin translating validated capability gaps into system-specific requirements including the Key Performance Parameters (KPPs) and Key System Attributes (KSAs), and to conduct planning to support a decision on the acquisition strategy for the product. AoA solutions, key trades among cost, schedule, and performance, affordability analysis, risk analysis, and planning for risk mitigation are key activities in this phase.

(b) Phase Description

1. Minimum funding required for this phase is normally that needed to analyze and select an alternative for materiel development, and to complete the activities necessary to support a decision to proceed to the next phase; technology development and concept analysis and design efforts may also be funded in this phase.

2. The validated ICD and the AoA Study Plan will guide the AoA and Materiel Solution Analysis Phase activity. The analysis will be conducted in accordance with the procedures in Enclosure 9 of this instruction, and focus on identification and analysis of alternatives; measures of effectiveness; key trades between cost and capability; total life-cycle cost, including sustainment; schedule; concepts of operations; and overall risk. The AoA will inform and be informed by affordability analysis, cost analysis, sustainment considerations, early systems engineering analyses, threat projections, and market research.

3. Prior to the completion of this phase, the DoD Component combat developer will prepare a Concept of Operations/Operational Mode Summary/Mission Profile (CONOPS/OMS/MP) that will include the operational tasks, events, durations, frequency, operating conditions and environment in which the recommended materiel solution is to perform each mission and each phase of a mission. The CONOPS/OMS/MP will be provided to the Program Manager and will inform development of the plans for the next phase including: acquisition strategy, test planning, and capability requirements trades. It will be provided to industry as an attachment for the next acquisition phase RFP.

4. This phase ends when a DoD Component has completed the necessary analysis and the activities necessary to support a decision to proceed to the next decision point and desired phase in the acquisition process. The next phase can be Technology Maturation and Risk Reduction (TMRR), EMD, or P&D, depending on the actions needed to mature the product being acquired. Each of these phases has associated decision points to authorize entry: Milestone A, Development RFP Release and Milestone B, or Milestone C. Each decision point and phase has information requirements identified in Table 2 in Enclosure 1 of this instruction, and other criteria as defined in paragraphs 5d(3) through 5d(14) in this instruction.

(c) Program Office Establishment and Next Phase Preparation. During the Materiel Solution Analysis Phase, the CAE will select a Program Manager and establish a Program Office to complete the necessary actions associated with planning the acquisition program with emphasis on the next phase. Prior to preparation and release of a final RFP for the planned next phase, the Program Manager should complete and submit the Acquisition Strategy and obtain MDA approval. An approved Acquisition Strategy will inform development of the final RFPs for the next phase of the program.

(3) Milestone A

(a) The Milestone A decision approves program entry into the TMRR Phase and release of final RFPs for TMRR activities. The responsible DoD Component may decide to perform technology maturation and risk reduction work in-house and/or award contracts

associated with the conduct of this phase. Competitive prototypes are part of this phase unless specifically waived by the MDA. Key considerations are:

1. The justification for the preferred materiel solution.

2. The affordability and feasibility of the planned materiel solution.

3. The scope of the capability requirements trade space and understanding of the priorities within that trade space.

4. The understanding of the technical, cost, and schedule risks of acquiring the materiel solution, and the adequacy of the plans and programmed funding to mitigate those risks prior to Milestone B.

5. The efficiency and effectiveness of the proposed acquisition strategy (including the contracting strategy and the intellectual property (IP) strategy) in light of the program risks and risk mitigation strategies.

6. The projected threat and its impact on the material solution.

(b) At the Milestone A Review:

1. The Program Manager will present the approach for acquiring the preferred materiel solution including: the Acquisition Strategy, the business approach, framing assumptions, an assessment of program risk and how specific technology development and other risk mitigation activities will reduce the risk to acceptable levels, and appropriate "Should Cost" management targets.

2. The DoD Component will:

a. Present an affordability analysis and proposed affordability goals based on the resources that are projected to be available to the DoD Component in the portfolio(s) or mission area(s) associated with the program under consideration. The analysis will be supported by a quantitative assessment of all of the programs in the prospective program's portfolio or mission area that demonstrates the ability of the Component's estimated budgets to fund the new program over its planned life cycle. Affordability analyses are not intended to produce rigid, long-range plans; their purpose is to inform current decisions about the reasonableness of embarking on long-term capital investments at specific capability levels. The affordability analysis will support the Component's proposed affordability goals for unit production and sustainment costs for MDA approval and inclusion in the Milestone A ADM. Enclosure 8 details the policy for affordability analyses and constraints.

b. Submit a DoD Component cost estimate for the preferred solution(s) identified by the AoA. Enclosure 10 covers cost estimating in greater detail.

c. Demonstrate that the program will be fully funded within the FYDP at Milestone A.

3. If Milestone A is approved, the MDA will make a determination on the materiel solution, the plan for the TMRR Phase, release of the final RFP, and specific exit criteria required to complete TMRR and enter EMD. The MDA will document these decisions in an ADM.

(c) If substantive changes to the plan approved at Milestone A are required as a result of the source selection process, the DoD Component will notify the MDA who may, at his or her discretion, conduct an additional review prior to contract awards.

(4) TMRR Phase

(a) Purpose. The purpose of this phase is to reduce technology, engineering, integration, and life-cycle cost risk to the point that a decision to contract for EMD can be made with confidence in successful program execution for development, production, and sustainment.

(b) Phase Description

1. This phase should include a mix of activities intended to reduce the specific risks associated with the product to be developed. This includes additional design trades and requirements trades necessary to ensure an affordable product and executable development and production programs. Capability requirements are matured and validated, and affordability caps are finalized during this phase. The TMRR Phase requires continuous and close collaboration between the program office and the requirements communities and authorities. During this phase, any realized Should Cost management savings should normally be used to further reduce program risk and future program costs. Enclosure 2 describes baseline cost control and the use of Should Cost management.

2. This phase normally includes competitive sources conducting technology maturation and risk reduction activities and preliminary design activities up to and including a Preliminary Design Review (PDR) prior to source selection for the EMD Phase.

a. Risk reduction prototypes will be included if they will materially reduce engineering and manufacturing development risk at an acceptable cost. Risk reduction prototypes can be at the system level or can focus on sub-systems or components.

b. A competitive prototype, or if this is not feasible, a single prototype or prototyping of critical subsystems prior to Milestone B is statutorily required to be part of the Acquisition Strategy for MDAPs and is a regulatory requirement for all other programs. The MDA may waive the competitive prototyping requirement at or prior to Milestone A if:

I. The cost of producing competitive prototypes exceeds the expected life-cycle benefits (in constant dollars) of producing the prototypes, including the benefits of

improved performance and increased technological and design maturity that may be achieved through competitive prototyping; or

II. The department would be unable to meet critical national security objectives without such a waiver.

3. There are a number of ways to structure this phase which should be tailored to reduce the specific risks associated with the product being acquired. Technology Readiness Levels, described in the Technology Readiness Assessment (TRA) Guidance (Reference (e)), should be used to benchmark technology risk during this phase; however, these indices are rough benchmarks, and not conclusive about the degree of risk mitigation needed prior to development. Deeper analysis of the actual risks associated with the preferred design and any recommended risk mitigation must be conducted and provided to the MDA.

(c) The Acquisition Strategy will guide this phase. Multiple technology development demonstrations, defined in the acquisition strategy, may be necessary before the operational user and material developer can substantiate that a preferred solution is feasible, affordable, and supportable; satisfies validated capability requirements; and has acceptable technical risk. Critical program information will be identified during this phase and program protection measures to prevent disclosure of critical information will be implemented consistent with section 13 in Enclosure 3. Planning for EMD, production, developmental and operational test, and life-cycle sustainment of proposed products will occur during this phase. The government will update the program IP Strategy (see paragraph 6a(4) of Enclosure 2) to ensure the ability to compete future sustainment efforts consistent with the Acquisition Strategy to include competition for spares and depot repair.

(d) During this phase, and timed to support CDD validation (or its equivalent), the Program Manager will conduct a systems engineering trade-off analysis showing how cost and capability vary as a function of the major design parameters. The analysis will support the assessment of refined KPPs/KSAs in the CDD. Capability requirements proposed in the CDD (or equivalent requirements document) should be consistent with program affordability goals.

(e) Subsequent to CDD validation, the Program Manager will conduct additional requirements analysis including: requirements decomposition and allocation, definition of internal and external interfaces, and design activities leading to a PDR. Unless waived by the MDA, the PDR will occur prior to Milestone B.

(f) Program Planning

1. During the TMRR Phase, the Program Manager will plan the balance of the program, prepare for subsequent decision points and phases, and submit an updated Acquisition Strategy for MDA approval. The updated Acquisition Strategy will describe the overall approach to acquiring the capability to include the program schedule, risks, funding, and the business strategy. The business strategy will describe the rationale for the contracting approach and how competition will be maintained throughout the program life cycle, and detail how contract incentives will be employed to support the Department's goals.

2. To avoid re-planning and program disruptions, an updated Acquisition Strategy should be submitted to the MDA in time for approval prior to the preparation of the final RFPs for the next phase.

(g) Life-Cycle Considerations During the TMRR Phase

1. Planning for the sustainment phase should begin in this phase, when requirements trades and early design decisions are still occurring. The Program Manager will finalize sustainment requirements and decompose them into more detailed requirements to support the PDR and for the following uses:

a. Support system and product support package design trades.

b. Support test and evaluation (T&E) planning.

c. Provide performance metrics definition for product support contracts and organic support requirements.

d. Provide logistics requirements, workload estimates, and logistics risk assessment.

2. The Program Manager will integrate the product support design into the overall design process, and assess enablers that improve supportability, such as diagnostics and prognostics, for inclusion in the system performance specification. As the design matures, the Program Manager will ensure that life-cycle affordability is a factor in engineering and sustainment trades.

(5) CDD Validation and Configuration Steering Boards (CSBs)

(a) CDD Validation

1. During the TMRR Phase, the requirements validation authority will validate the CDD (or equivalent requirements document) for the program. This action will precede the Development RFP Release Decision Point and provides a basis for preliminary design activities and the PDR that will occur prior to Milestone B unless waived by the MDA. Active engagement between acquisition leadership, including the MDA, and the requirements leadership, including the validation authority (the JROC for MDAP and MAIS programs), during the development and review of proposed requirements trades is essential to ensuring that the validated requirements associated with the program continue to address the priorities of the DoD Component and the joint force in a cost effective and affordable way. The MDA (and CAE when the MDA is the DAE) will participate in the validation authorities' review and staffing of the CDD (or equivalent requirements document) prior to validation, to ensure that requirements are technically achievable, affordable, and testable, and that requirements trades are fully informed by systems engineering trade-off analyses completed by the Program Manager or the DoD Component.

2. The KPPs and KSAs included in the validated CDD, will guide the efforts leading up to PDR, and inform the Development RFP Release Decision Point. As conditions warrant, changes to KPPs and KSAs may be proposed to the applicable capability requirements validation authority. All non-KPP requirements (when delegated by the capability requirements validation authority) are subject to cost-performance trades and adjustments to meet affordability constraints. Cost performance trades (for non-KPP requirements) will be coordinated with the cognizant capability requirements validation authority.

(b) CSBs. For ACAT I and ACAT IA programs, and following CDD Validation, the Acquisition Executive of each DoD Component will form and chair a CSB with broad executive membership including senior representatives from the Office of the USD(AT&L) (including the Assistant Secretary of Defense for Acquisition), the Joint Staff (Director of Force Structure, Resources, and Assessments, J-8), and the DoD Chief Information Officer; empowered representatives from the Service Chief of Staff and comptroller offices of the Military Department concerned; representatives from other Military Departments where appropriate; the Military Deputy to the CAE; the PEO; and other senior representatives from OSD and the DoD Component, as appropriate, in accordance with section 814 of Public Law (P.L.) 110-417 (Reference (f)). DoD Components should also form appropriate level and composition CSBs for lower ACAT programs.

1. The CSB will meet at least annually, and more frequently as capability requirements or content trades are needed, to review all requirements changes and any significant technical configuration changes for ACAT I and IA programs in development, production, and sustainment that have the potential to result in cost and schedule impacts to the program. The CSB will review potential capability requirements changes and propose to the requirements validation authority those changes that may be necessary to achieve affordability constraints on production and sustainment costs or that will result in a more cost-effective product. Changes that increase cost will not be approved unless funds are identified and schedule impacts are addressed. Program requirements will fall under the cognizance of the CSB upon receipt of a validated CDD or other validated requirements document, and before the Development RFP Release Decision Point. CSBs may also be formed earlier in the program at the discretion of the CAE.

2. The Program Manager, in consultation with the PEO and the requirements sponsor, will, on at least an annual basis, identify and propose to the CSB a set of recommended requirements changes to include descoping options that reduce program cost and/or moderate requirements and changes needed to respond to any threat developments. These options will be presented to the CSB with supporting rationale addressing operational implications. The chair of the CSB will recommend to the DoD Component requirements authority, the validation authority, and the DAE (if an ACAT ID or MAIS program and KPPs are affected) which of these options should be implemented.

(6) Development RFP Release Decision Point

(a) This decision point authorizes the release of RFPs for EMD and often for LRIP or Limited Deployment options. This review is the critical decision point in an acquisition

program. The program will either successfully lead to a fielded capability or fail, based on the soundness of the capability requirements, the affordability of the program, and the executability of the acquisition strategy. The acquisition strategy is put into execution at this decision point by asking industry for bids that comply with the strategy. Release of the RFP for EMD sets in motion all that will follow. This is the last point at which significant changes can be made without a major disruption.

(b) The purpose of the Development RFP Release Decision Point is to ensure, prior to the release of the solicitation for EMD, that an executable and affordable program has been planned using a sound business and technical approach. One goal at this point is to avoid any major program delays at Milestone B, when source selection is already complete and award is imminent. Therefore, prior to release of final RFPs, there needs to be confidence that the program requirements to be bid against are firm and clearly stated; the risk of committing to development and presumably production has been or will be adequately reduced prior to contract award and/or option exercise; the program structure, content, schedule, and funding are executable; and the business approach and incentives are structured to both provide maximum value to the government and treat industry fairly and reasonably.

(c) At the Development RFP Release Decision Point, the Program Manager will summarize TMRR Phase progress and results, and review the Acquisition Strategy for the EMD Phase. Specific attention will be given to overall affordability; the competition strategy and incentive structure; provisions for small business utilization; source selection criteria including any "best value" determination; framing assumptions; engineering and supportability trades and their relationship to validated capability requirements; the threat projections applicable to the system; Should Cost targets; risk management plans; and the basis for the program schedule.

(d) Documents required for the Development RFP Release Decision Point will be submitted no later than 45 calendar days prior to the review. These documents may have to be updated for final approval by the appropriate authority prior to Milestone B and any associated EMD contract awards based on the results of the source selection. For programs for which the DAE is the MDA, appropriate sections of the EMD RFP and its attachments will be reviewed by relevant OSD staff personnel in support of this decision point, after obtaining specific authority in writing from the cognizant contracting officer.

(e) For MDAPs and major systems, the MDA will determine the preliminary LRIP quantity (or the scope of limited deployment for MAIS programs) at the Development RFP Release Decision Point. LRIP quantities will be the minimum needed to provide production representative test articles for operational test and evaluation (OT&E) (as determined by DOT&E for MDAPS or special interest programs), to establish an initial production base for the system and provide efficient ramp up to full-rate production, and to maintain continuity in production pending completion of operational testing. The final LRIP quantity for an MDAP (with rationale for quantities exceeding 10 percent of the total production quantity documented in the Acquisition Strategy) must be included in the first Selected Acquisition Report submitted to Congress after quantity determination. Table 5 in Enclosure 1 provides details about the Selected Acquisition Report.

(f) For incrementally deployed software intensive programs, the MDA will determine the preliminary scope of limited deployment that will be adequate to evaluate fielding plan execution and support OT&E prior to a Full Deployment Decision for each capability increment.

(g) Decisions resulting from the Development RFP Release Decision Point will be documented in an ADM. The ADM will document specific criteria required for Milestone C approval including needed test accomplishments, LRIP quantities, affordability requirements, and FYDP funding requirements. Table 2 in Enclosure 1 of this instruction identifies the requirements that must be satisfied at this review.

(7) PDR. During the TMRR Phase, and unless waived by the MDA, a PDR will be conducted so that it occurs before Milestone B and prior to contract award for EMD. The timing of the PDR relative to the Development RFP Release Decision Point is at the discretion of the DoD Component. The Component should balance the need for more mature design information to support source selection with the costs of either: (1) extending multiple sources' design activities from the PDR until award of the full EMD contract or (2) having a gap in development prior to EMD award. Unless waived by the MDA, PDR results will be assessed by the MDA prior to the MDA Certification pursuant to section 2366b of Title 10, U.S. Code (Reference (g)) and Milestone B approval for MDAPs (hereafter, U.S. Code citations are presented as [title #] U.S.C. [section #], e.g., "10 U.S.C. 2366b"). Table 6 in Enclosure 1 of this instruction lists required waiver documentation and actions.

(8) Milestone B

(a) This milestone provides authorization to enter into the EMD Phase and for the DoD Components to award contracts for EMD. It also commits the required investment resources to the program. Most requirements for this milestone should be satisfied at the Development RFP Release Decision Point; however, if any significant changes have occurred, or if additional information not available at the Development RFP Release Decision Point could impact this decision, it must be provided at the Milestone B. Milestone B requires final demonstration that all sources of risk have been adequately mitigated to support a commitment to design for production. This includes technology, engineering, integration, manufacturing, sustainment, and cost risks. Validated capability requirements, full funding in the FYDP, and compliance with affordability goals for production and sustainment, as demonstrated through an independent cost estimate (ICE), are required. The framing assumptions central to shaping the program's cost, schedule, and performance expectations are also required.

(b) Milestone B is normally the formal initiation of an acquisition program with the MDA's approval of the Acquisition Program Baseline (APB). The APB is the agreement between the MDA and the Program Manager and his or her acquisition chain of command that will be used for tracking and reporting for the life of the program or program increment (see section 4 in Enclosure 1 of this instruction for additional policy regarding APBs). The APB will include the affordability caps for unit production and sustainment costs. Affordability caps are established as fixed cost requirements equivalent to KPPs.

(c) At the milestone, the MDA will finalize the following, if not already completed:

1. The LRIP quantity or the scope of limited deployment, as applicable.

2. The specific technical event-based criteria for initiating production or making deployment decisions.

3. Document decisions in an ADM.

(d) Table 2 in Enclosure 1 identifies the statutory and regulatory requirements for Milestone B.

(9) EMD Phase

(a) Purpose. The purpose of the EMD Phase is to develop, build, and test a product to verify that all operational and derived requirements have been met, and to support production or deployment decisions.

(b) Phase Description

1. General. EMD completes all needed hardware and software detailed design; systemically retires any open risks; builds and tests prototypes or first articles to verify compliance with capability requirements; and prepares for production or deployment. It includes the establishment of the initial product baseline for all configuration items.

a. Design. The system design effort usually includes a standard series of design reviews prior to test article fabrication and/or software build or increment coding. Multiple design iterations may be necessary to converge on a final design for production. The SEP, described in section 2 in Enclosure 3 of this instruction, provides the basis for design activities.

b. Post-Milestone B PDR. If a PDR prior to Milestone B has been waived, the Program Manager will plan for a PDR as soon as feasible after program initiation.

2. Developmental Test and Evaluation (DT&E). Developmental testing and evaluation provides feedback to the Program Manager on the progress of the design process and on the product's compliance with contractual requirements. DT&E activities also evaluate the ability of the system to provide effective combat capability, including its ability to meet its validated and derived capability requirements, including the verification of the ability of the system to achieve KPPs and KSAs, and that initial system production and deployment and OT&E can be supported. The effort requires completion of DT&E activities consistent with the TEMP. Successful completion of adequate testing with production or deployment representative prototype test articles will normally be the primary basis for entering LRIP or Limited Deployment. Enclosure 4 includes more detailed discussions of DT&E requirements.

3. Early OT&E Events. Independent operational assessments, conducted by the Component operational test organization, will normally also occur during EMD. These events

may take the form of independent evaluation of developmental test results or of separate dedicated test events such as Limited User Tests. Developmental and operational test activities should, to the extent feasible, be planned in conjunction with one another to provide as efficient an overall test program as possible. Enclosures 4 and 5 provide more detailed discussions of DT&E and OT&E.

(c) Preparation for Production, Deployment, and Sustainment. During EMD, the Program Manager will finalize designs for product support elements and integrate them into a comprehensive product support package. Early in the EMD Phase, the Program Manager's initial product support performance requirements allocations will be refined based on the results of engineering reviews. Later in this phase, programs will demonstrate product support performance through test, to ensure the system design and product support package meet the sustainment requirements within the affordability caps established at Milestone B.

(d) EMD Phase Completion. The EMD Phase will end when: (1) the design is stable; (2) the system meets validated capability requirements demonstrated by developmental and initial operational testing as required in the TEMP; (3a) manufacturing processes have been effectively demonstrated and are under control; (3b) software sustainment processes are in place and functioning; (4) industrial production capabilities are reasonably available; and (5) the system has met or exceeds all directed EMD Phase exit criteria and Milestone C entrance criteria. EMD will often continue past the initial production or fielding decision until all EMD activities have been completed and all requirements have been tested and verified.

(e) Concurrency Between EMD and Production. In most programs for hardware intensive products, there will be some degree of concurrency between initial production and the completion of developmental testing; and perhaps some design and development work, particularly completion of software, that will be scheduled to occur after the initial production decision. Concurrency between development and production can reduce the lead time to field a system, but it also can increase the risk of design changes and costly retrofits after production has started. Program planners and decision authorities should determine the acceptable or desirable degree of concurrency based on a range of factors. In general, however, there should be a reasonable expectation, based on developmental testing of full-scale EMD prototypes, that the design is stable and will not be subject to significant changes following the decision to enter production. At Milestone B, the specific technical event-based criteria for initiating production or fielding at Milestone C will be determined and included in the Milestone B ADM.

(f) Release of the P&D RFP. If the strategy and associated business arrangements planned and approved at Milestone B have been changed as a result of EMD phase activity, or if the validated capability requirements have changed, an updated Acquisition Strategy will be submitted for MDA review and approval prior to the release of the RFP for competitive source selection or the initiation of sole source negotiations. In any event, an updated Acquisition Strategy will be submitted prior to Milestone C and contract award, consistent with the procedures specified in this document. Paragraph 6a in Enclosure 2 provides additional detail about the Acquisition Strategy.

(g) Additional EMD Phase Requirements

1. Inherently Government Functions and Lead System Integrators (LSI). Program managers will emphasize the importance of appropriate checks and balances when contractors perform acquisition-related activities and ensure that the government is singularly responsible for the performance of inherently governmental functions. If the Acquisition Strategy for a major system calls for the use of a LSI, a contract will not be awarded to an offeror that either has or is expected to acquire a direct financial interest in the development or construction of an individual system or an element of a system of systems within the major system under the LSI. Exceptions may be granted by the MDA, as provided in 10 U.S.C. 2410p (Reference (g)), that require certification to the Committees on Armed Services of the Senate and House of Representatives. Table 6 in Enclosure 1 of this instruction provides details about the exception reporting.

2. Advanced Procurement of Long Lead Production Items. The MDA may authorize long lead at any point during EMD or at the Development RFP Release Decision or Milestone B, subject to the availability of appropriations. These items are procured in advance of a Milestone C production decision in order to provide for a more efficient transition to production. The amount of long lead appropriate for a given program depends on the type of product being acquired. The product's content dictates the need for early purchase of selected components or subsystems to implement a smooth production process. Long lead authorization will be documented in an ADM and limited in content (i.e., listed items) and/or dollar value within the authorizing ADM.

(10) Milestone C

(a) Milestone C and the Limited Deployment Decision are the points at which a program or increment of capability is reviewed for entrance into the P&D Phase or for Limited Deployment. Approval depends in part on specific criteria defined at Milestone B and included in the Milestone B ADM. The following general criteria will normally be applied: demonstration that the production/deployment design is stable and will meet stated and derived requirements based on acceptable performance in developmental test events; an operational assessment; mature software capability consistent with the software development schedule; no significant manufacturing risks; a validated Capability Production Document (CPD) or equivalent requirements document; demonstrated interoperability; demonstrated operational supportability; costs within affordability caps; full funding in the FYDP; properly phased production ramp up; and deployment support.

1. In making Milestone C and Limited Deployment decisions, the MDA will consider any new validated threat environments that were not included in the CPD and might affect operational effectiveness, and will consult with the requirements validation authority as part of the production decision making process to ensure that capability requirements are current.

2. MDA decisions at Milestone C and Limited Deployment Decisions will be documented in an ADM following the review. Table 2 in Enclosure 1 identifies the statutory and regulatory requirements that will be satisfied at Milestone C.

(b) High-Cost First Article Combined Milestone B and C Decisions. Some programs, notably spacecraft and ships, will not produce prototypes during EMD for use solely as test articles because of the very high cost of each article. In this case, the first articles produced will be tested and then fielded as operational assets. These programs may be tailored by measures such as combining the development and initial production investment commitments. When this is the case, a combined Milestone B and C will be conducted. Additional decision points with appropriate criteria may also be established for subsequent low rate production commitments that occur prior to OT&E and a Full-Rate Production Decision.

(11) Production and Deployment (P&D) Phase

(a) Purpose. The purpose of the P&D Phase is to produce and deliver requirements-compliant products to receiving military organizations.

(b) Phase Description. In this phase, the product is produced and fielded for use by operational units. The phase encompasses several activities and events: LRIP, Limited Deployment, OT&E, and the Full-Rate Production Decision or the Full Deployment Decision followed by full-rate production or full deployment. In this phase, all system sustainment and support activities are initiated if they haven't already commenced. During this phase the appropriate operational authority will declare IOC when the defined operational organization has been equipped and trained and is determined to be capable of conducting mission operations. During this phase Should Cost management and other techniques will be used continuously to control and reduce cost.

1. LRIP and Limited Deployment. LRIP establishes the initial production base for the system or capability increment, provides the OT&E test articles, provides an efficient ramp up to full-rate production, and maintains continuity in production pending OT&E completion. While this portion of the phase should be of limited duration so that efficient production rates can be accomplished as soon and as economically as possible, it should be of sufficient duration to permit identification and resolution of any deficiencies prior to full-rate production. Limited Deployment for software developments is principally intended to support OT&E and can, consistent with the program strategy, be used to provide tested early operational capability to the user prior to full deployment.

2. OT&E. The appropriate operational test organization will conduct operational testing in a realistic threat environment. The threat environment will be based on the program's System Threat Assessment Report and appropriate scenarios. For MDAPs, MAIS programs, and other programs on the DOT&E Oversight List, the DOT&E will provide a report providing the opinion of the DOT&E as to whether the program is operationally effective, suitable, and survivable before the MDA makes a decision to proceed beyond LRIP. For programs on the DOT&E Oversight List, operational testing will be conducted in accordance with the approved TEMP and operational test plan. If LRIP is not conducted for programs on the DOT&E Oversight List, fully production-representative articles must nonetheless be provided for the conduct of the required operational testing. Enclosure 4 and Enclosure 5 provide details about developmental and operational testing and the TEMP.

(12) Full-Rate Production Decision or Full Deployment Decision. The MDA will conduct a review to assess the results of initial OT&E, initial manufacturing, and limited deployment, and determine whether or not to approve proceeding to Full-Rate Production or Full Deployment. Continuing into Full-Rate Production or Full Deployment requires demonstrated control of the manufacturing process, acceptable performance and reliability, and the establishment of adequate sustainment and support systems.

(a) In making the Full-Rate Production Decision or the Full Deployment Decision, the MDA will consider any new validated threat environments that might affect operational effectiveness, and may consult with the requirements validation authority as part of the decision making process to ensure that capability requirements are current.

(b) Except as specifically approved by the MDA, critical deficiencies identified in testing will be resolved prior to proceeding beyond LRIP or limited deployment. Remedial action will be verified in follow-on test and evaluation.

(c) The decision to proceed into full-rate production or full deployment will be documented in an ADM. Table 2 in Enclosure 1 identifies the statutory and regulatory requirements associated with this decision.

(13) Full-Rate Production or Full Deployment. In this part of the P&D Phase, the remaining production or deployment of the product is completed, leading to Full Operational Capability or Full Deployment.

(14) Operations and Support (O&S) Phase

(a) Purpose. The purpose of the O&S Phase is to execute the product support strategy, satisfy materiel readiness and operational support performance requirements, and sustain the system over its life cycle (to include disposal). The O&S Phase begins after the production or deployment decision and is based on an MDA-approved LCSP. Enclosure 6 includes a more detailed discussion of sustainment planning; Enclosure 7 addresses planning for human systems integration.

(b) Phase Description. The phase has two major efforts, Sustainment and Disposal. The LCSP, prepared by the Program Manager and approved by the MDA, is the basis for the activities conducted during this phase.

1. Sustainment. During this phase, the Program Manager will deploy the product support package and monitor its performance according to the LCSP. The LCSP may include time-phased transitions between commercial, organic, and partnered product support providers. The Program Manager will ensure resources are programmed and necessary IP deliverables and associated license rights, tools, equipment, and facilities are acquired to support each of the levels of maintenance that will provide product support; and will establish necessary organic depot maintenance capability in compliance with statute and the LCSP.

a. A successful program meets the sustainment performance requirements, remains affordable, and continues to seek cost reductions by applying Should Cost management and other techniques throughout the O&S Phase. Doing so requires close coordination with the war-fighting sponsor (i.e., user), resource sponsors, and materiel enterprise stake holders, along with effective management of support arrangements and contracts. During O&S, the Program Manager will measure, assess, and report system readiness using sustainment metrics and implement corrective actions for trends diverging from the required performance outcomes defined in the APB and LCSP.

b. Over the system life cycle, operational needs, technology advances, evolving threats, process improvements, fiscal constraints, plans for follow-on systems, or a combination of these influences and others may warrant revisions to the LCSP. When revising the LCSP, the Program Manager will revalidate the supportability analyses and review the most current product support requirements, senior leader guidance, and fiscal assumptions to evaluate product support changes or alternatives and determine best value.

2. Disposal. At the end of its useful life, a system will be demilitarized and disposed of in accordance with all legal and regulatory requirements and policy relating to safety (including explosives safety), security, and the environment.

e. Additional Procedures and Guidance

(1) The enclosures to this instruction contain additional acquisition policy and procedures that guide program planning.

(a) Enclosure 1 details the programmatic requirements established by statute or regulation. It defines acquisition program categories and compliance requirements for those categories.

(b) Enclosures 2 through 10 provide specific policy and procedures applicable in various functional areas across the life cycle of the acquired system.

(c) Enclosure 11 provides specific policy applicable to programs containing information technology.

(d) Enclosure 12 provides specific policy and procedures applicable to Defense Business Systems.

(e) Enclosure 13 provides specific policy and procedures applicable to Urgent Needs.

(2) Consistent with program requirements and subparagraphs 4b and 4c, MDAs may tailor the information requirements and procedures in this section of the instruction and in Enclosures 1 through 13. As stated in paragraph 4c, some exceptions to regulatory policy may require coordination with the cognizant authority. Statutory requirements will not be waived unless permitted by the statute.

6. RELEASABILITY. **Cleared for public release**. This instruction is available on the Internet from the DoD Issuances Website at http://www.dtic.mil/whs/directives.

7. EFFECTIVE DATE. This instruction is effective January 7, 2015.

Frank Kendall Under Secretary of Defense for Acquisition, Technology, and Logistics	J. Michael Gilmore Director, Operational Test and Evaluation	Terry Halvorsen Acting DoD Chief Information Officer

References
Enclosures
1. Acquisition Program Categories and Compliance Requirements
2. Program Management
3. Systems Engineering
4. Developmental Test and Evaluation (DT&E)
5. Operational and Live Fire Test and Evaluation (OT&E and LFT&E)
6. Life-Cycle Sustainment
7. Human Systems Integration (HSI)
8. Affordability Analysis and Investment Constraints
9. Analysis of Alternatives (AoA)
10. Cost Estimating and Reporting
11. Requirements Applicable to All Programs Containing Information Technology (IT)
12. Defense Business Systems (DBS)
13. Rapid Fielding of Capabilities

Glossary

LESSON ASSIGNMENT SHEET

Lesson Number Exercise 2.1

Lesson Title Acquisition Strategy Development

Lesson Time 7.5 hours

Terminal and Enabling Learning Objectives

TLO		**Prepare an acquisition strategy program structure chart showing appropriate interrelationship(s) of the various business and technical functions involved in planning and executing the program:**
	ELO	Given an acquisition program scenario with information on technology maturity, funding and JCIDS documentation, identify the correct starting point for the program in the acquisition lifecycle
	ELO	Identify the correct type of appropriated funds needed by phase and work effort
	ELO	Given an acquisition program structure chart identify the correct sequence and timing of technical reviews by phase and work effort
	ELO	Given an acquisition program structure chart identify the correct sequence and timing of developmental and operational test events by phase and work effort
	ELO	Given an acquisition program structure chart identify the correct sequence and timing of lifecycle logistics planning and execution efforts by phase and work effort
	ELO	Given an acquisition program structure chart, identify the appropriate contract types by phase and work effort
	ELO	Given an acquisition program structure chart, identify the timing of major hardware deliverables by phase and work effort
	ELO	Relate the capability documents (ICD,CDD,CPD) to the correct phases of the acquisition system
	ELO	Identify the evolutionary acquisition strategy approach
	ELO	Identify the single step acquisition strategy approach
TLO		**Modify, present, and defend an acquisition strategy to accommodate a change in program funding levels**
	ELO	Identify the proper response to a program funding cut
	ELO	Given a program funding cut, identify the potential impacts on industry.

Assignments	• Scan Pages 2-14 of the DoDI 5000.02 • Read Pages 15-19 DoDI 5000.02 • Review the following ACQ 202 CBT Lesson Summary: - Lesson 2.2, Developing the Acquisition Strategy
Estimated Student Preparation Time	45 minutes
Assessment	Class participation; oral presentation
Related Lessons	CBT Lesson 2.2, Developing the Acquisition Strategy Classroom Exercise 1.3, Materiel Solution Analysis
Self Study References	• DoDD 5000.01, *The Defense Acquisition System*, 12 May 2003 • DoDI 5000.02, *Operation of the Defense Acquisition System*, 2 *January 7, 2015 Defense Acquisition Guidebook, Chaps 2 & 4*

Defining Desired Capabilities

USER NEEDS & TECHNOLOGY OPPORTUNITIES	
Source of User Needs	**Technology Opportunities**
Joint Capabilities Integrated Development System (JCIDS) ▪ Joint Concept of Operations ▪ Joint integrated architectures ▪ DOTMLPF-P analysis **Which lead to:** ▪ Initial Capabilities Document (ICD)	**Science & Technology (S&T) Activities** ▪ ATDs ▪ JCTDs ▪ Joint War Fighting Experiments

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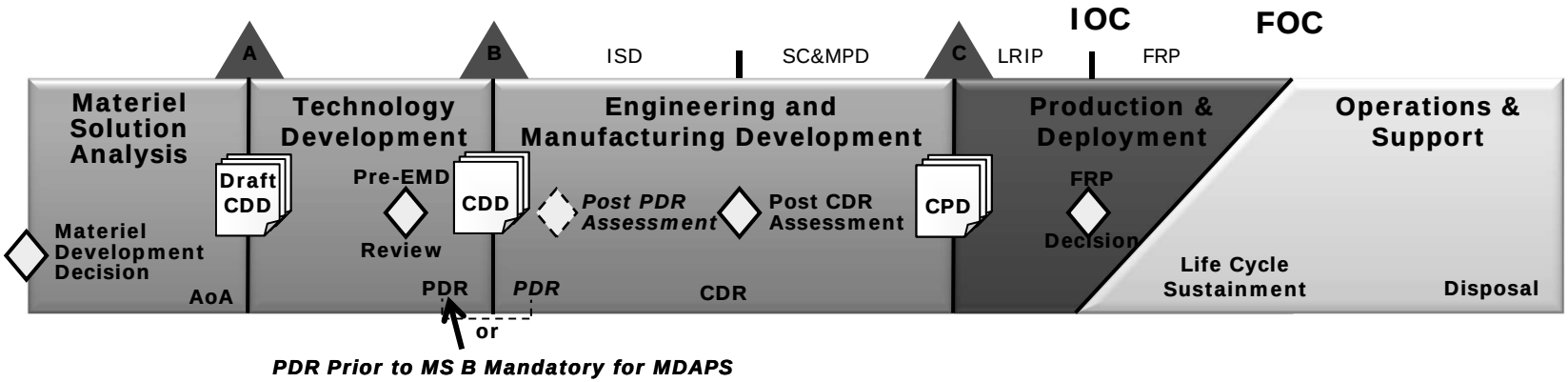
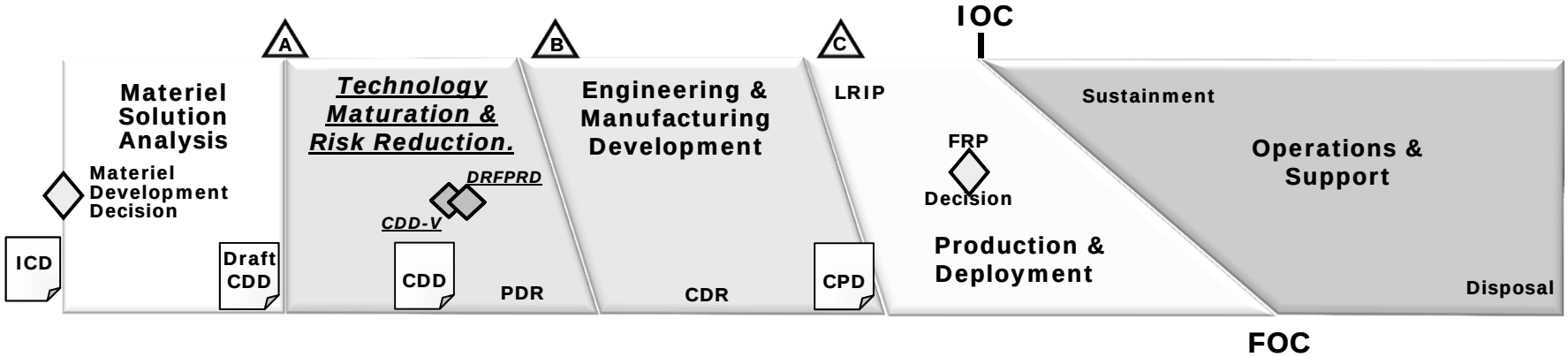


2015 (Model 1: Hardware Intensive Program)

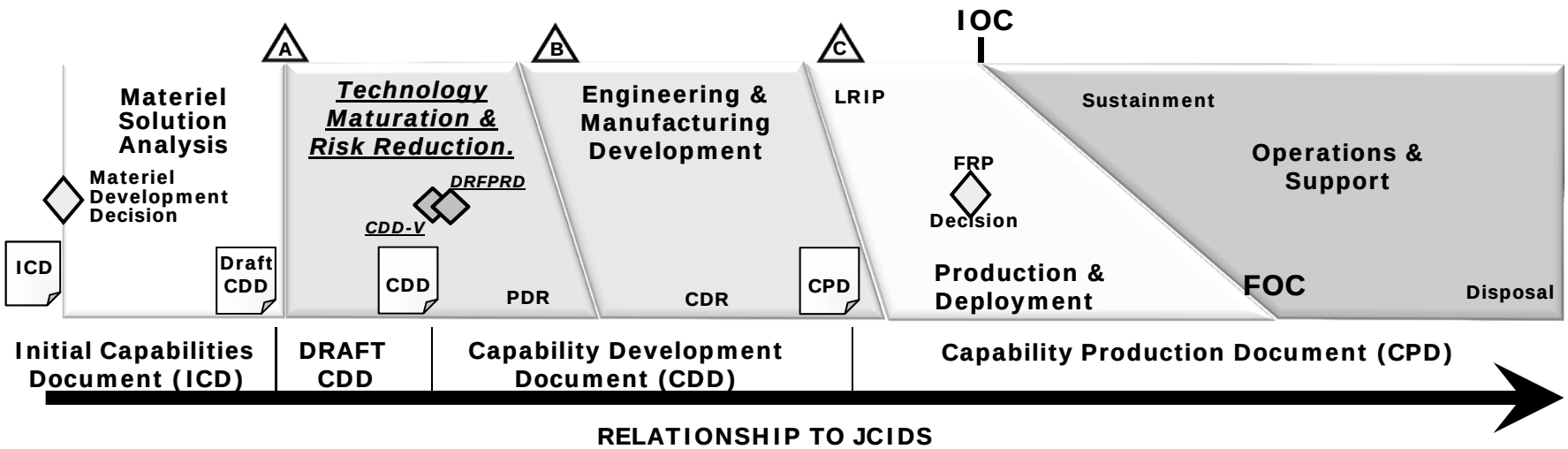


- 5 additional models including hybrid hardware and software models with emphasis on tailoring
- Annual high level Configuration Steering Boards (CSBs) to address cost/performance trades
- Initial Acquisition Strategy, Cyber Security Strategy, TEMP, SEP and LCSP all due at Milestone A
- Independent Logistics Assessments (ILAs) before each decision point starting at Milestone B
- Program Office established and PM assigned during Materiel Solution Analysis phase
- Emphasis on thoughtful planning vs. compliance

The Defense Acquisition Management System

- The Materiel Development Decision precedes entry into any phase of the acquisition management system
- Entrance Criteria met before entering phase
- Evolutionary Acquisition or Single Step to Full Capability

Model 1: Hardware Intensive Program



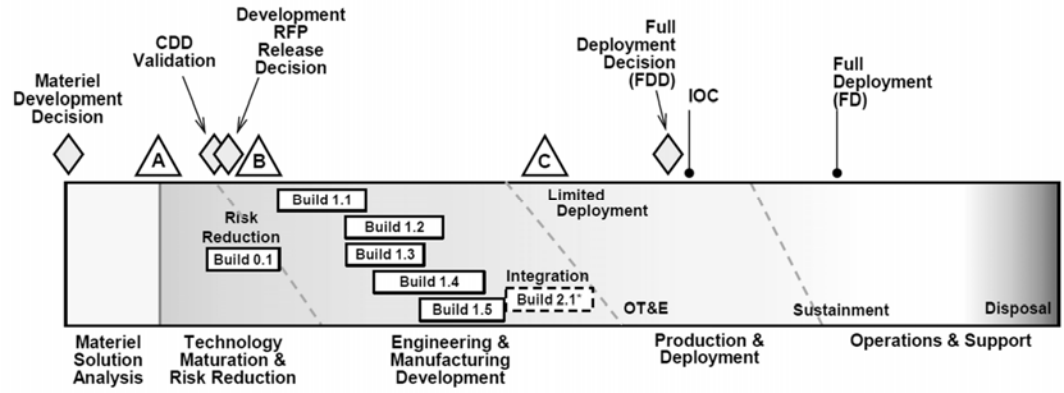
▪ PDR: Preliminary Design Review ▪ CDR: Critical Design Review ▪ CDD-V: CDD Validation	▪ LRIP: Low Rate Initial Production ▪ FRP: Full Rate Production ▪ DRFPRD: Development Request For Proposals Release Decision	▪ IOC: Initial Operational Capability ▪ FOC: Full Operational Capability

Achieving Full Capability

Two strategy approaches to full capability: *evolutionary* and *single-step*.

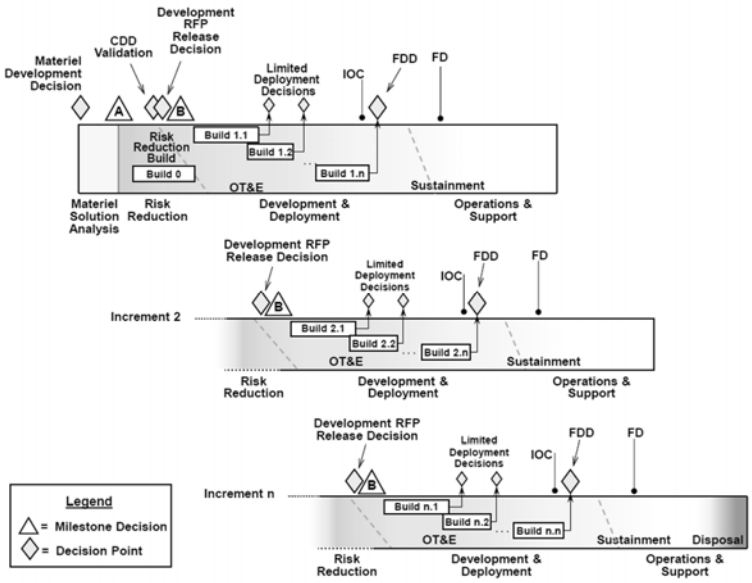
- Particular approach chosen depends on:
  - Availability of time-phased capabilities in the CDD
  - Technology maturity
  - Cost/benefit of incremental fielding vs. single step
  - Cost of fielding multiple configurations
    - Retrofit decisions & cost
    - Training
    - Supportability
- Acquisition strategy shall address chosen approach
- **Evolutionary acquisition** is the **preferred strategy** for rapid acquisition of mature technology

Model 2: Defense Unique Software Intensive Program



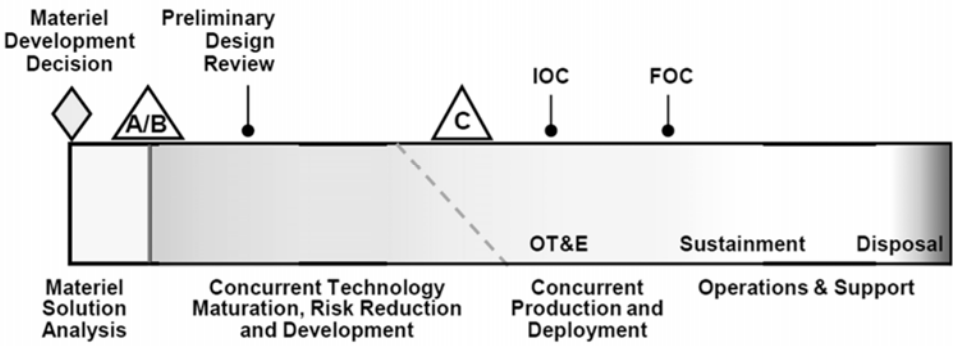
- …a model of a program that is dominated by the need to develop a complex, usually defense unique, software program that will not be deployed until several software builds have been completed
- The central feature of this model is the planned software builds – a series of testable, integrated subsets of the overall capability – which together with clearly defined decision criteria, ensure adequate progress is being made before fully committing to subsequent builds
- Examples of this type of product include military unique command and control systems and significant upgrades to the combat systems found on major weapons systems such as surface combatants and tactical aircraft.

Model 3: Incrementally Deployed Software Intensive Program



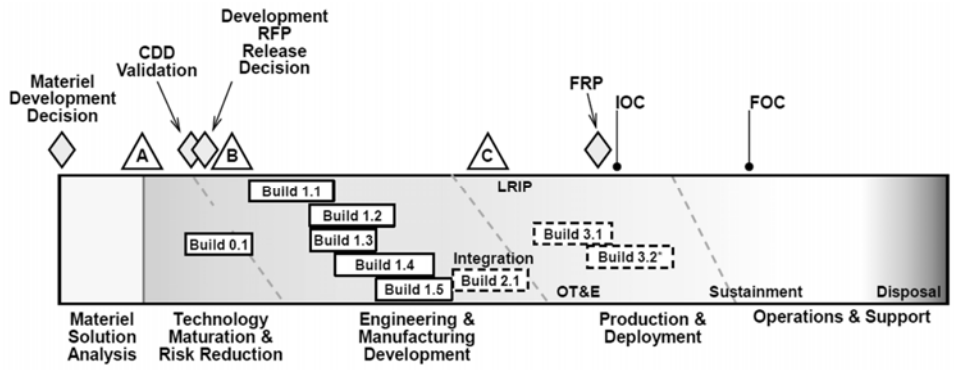
- This model is distinguished from the previous model by the rapid delivery of capability through multiple acquisition increments, each of which provides part of the overall required program capability. Each increment may have several limited deployments; each deployment will result from a specific build and provide the user with a mature and tested sub-element of the overall incremental capability.
- Several builds and deployments will typically be necessary to satisfy approved requirements for an increment of capability.
- …will apply in cases where commercial off-the-shelf software, such as commercial business systems with multiple modular capabilities, are acquired and adapted for DoD applications.

Model 4: Accelerated Acquisition Program



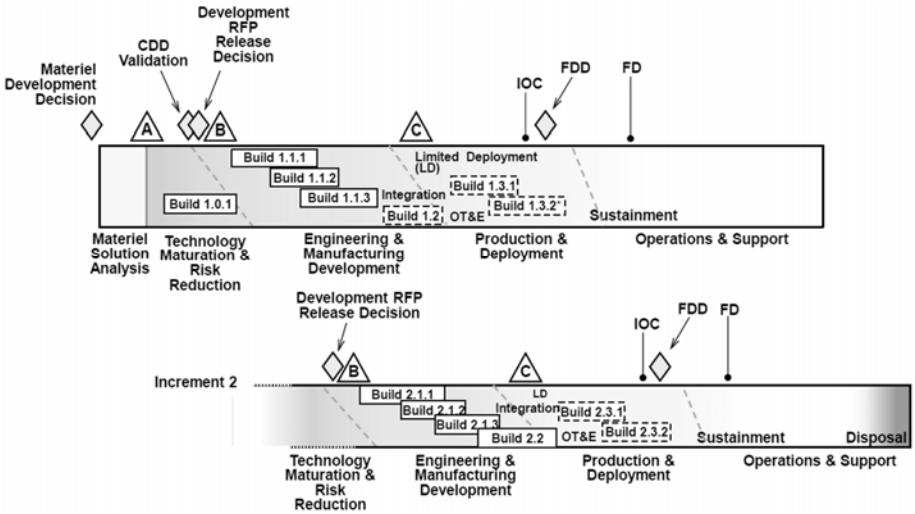
- … is a model that applies when schedule considerations dominate over cost and technical risk considerations
- This model compresses or eliminates phases of the process and accepts the potential for inefficiencies in order to achieve a deployed capability on a compressed schedule
- The model shows one example of tailoring for accelerated acquisition and many others are possible
- This type of structure is used when technological surprise by a potential adversary necessitates a higher-risk acquisition program. Procedures applicable to urgent needs that can be fulfilled in less than 2 years are a subset of this model and are discussed in Enclosure 13.

Model 5: Hybrid Program A (Hardware Dominant)



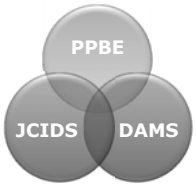
- … a model depicting how a major weapons system combines hardware development as the basic structure with a software intensive development that is occurring simultaneously with the hardware development program
- In a hardware intensive development, the design, fabrication, and testing of physical prototypes may determine overall schedule, decision points, and milestones, but software development will often dictate the pace of program execution and must be tightly integrated and coordinated with hardware development decision points
- … software development should be organized into a series of testable software builds
- These builds should lead up to the full capability needed to satisfy program requirements and Initial Operational Capability (IOC). Software builds should be structured so that the timing of content delivery is synchronized with the need for integration, developmental and operational testing in hardware prototypes
- … Milestone B decision to enter EMD and the Milestone C decision to enter Production and Deployment should include software functional capability development maturity criteria as well as demonstrated technical performance exit criteria.

Model 6: Hybrid Program B (Software Dominant)

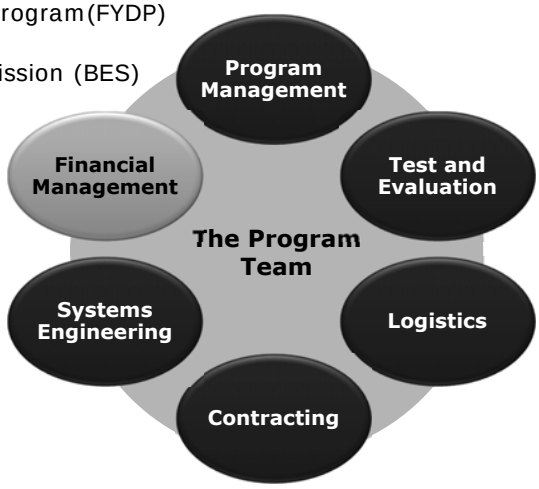


- … depicts how a software intensive product development can include a mix of incrementally deployed software products or releases that include intermediate software builds.
- <u>Risk Management in Hybrid Models</u>:
  - Highly integrated complex software and hardware development poses special risks to program cost and schedule performance.
  - Technical, cost, and schedule risks associated with hardware and software development must be managed throughout the program's life cycle and will be a topic of special interest at all decision points and milestones.

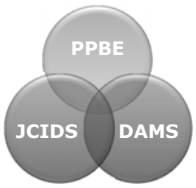
PPBE Phases



- **Planning**
  - Review threat / assess capabilities
  - Develop guidance
  - Defense Planning Guidance (DPG)
- **Programming**
  - Turn guidance into achievable and affordable packages / programs
  - Program Objective Memorandum (POM)
  - Future Years Defense Program(FYDP)
- **Budgeting**
  - Budget Estimate Submission (BES)
  - Scrub budget year
  - First year of FYDP
- **Execution**
  - Measure performance against plan
  - Assess effectiveness of resource allocations



"Colors" of Money



Appropriation Category	Life
Operation & Maintenance (O&M)	1 year
MILPERS	1 year
RDT&E	2 years
Procurement (excluding SCN)	3 years
SCN (Shipbuilding & Conversion, Navy)	5 years
MILCON	5 years

** All appropriation categories are good for period of obligation plus five years for paying bills*

Risk and Contract Types

Greatest Cost Risk to the Contractor →

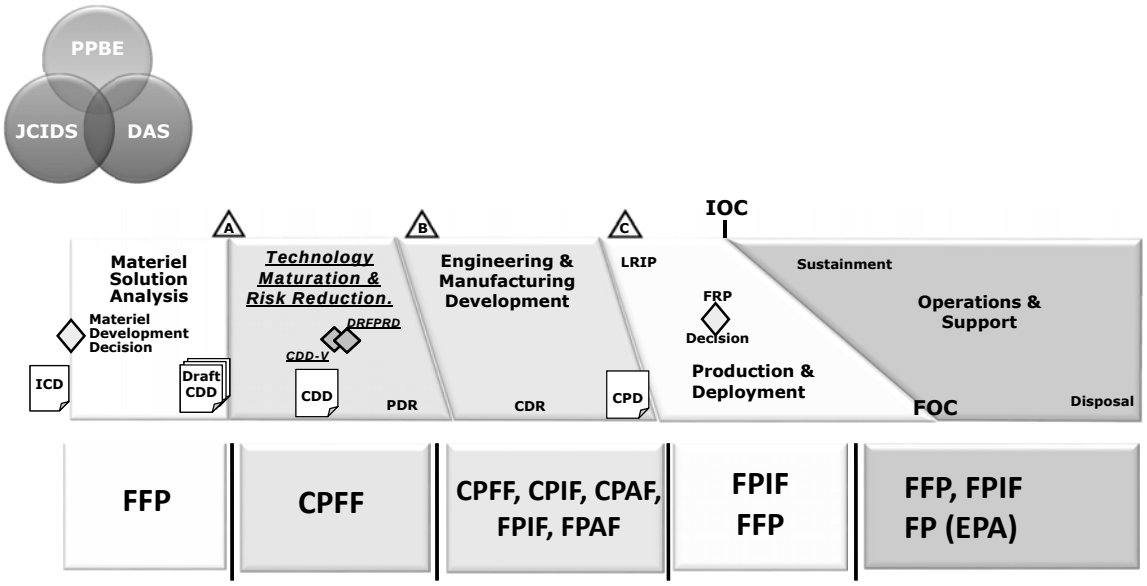
← **Greatest Cost Risk to the Government**

CPFF	CPIF	*CPAF*	*FPI (F)*	*FPAF*	*FFP*

Technical Risk

Vague technical requirements; labor and material costs uncertain	Technical requirements defined; fair & reasonable prices determinable
Contractor Delivers "Best Effort"	Contractor Delivers Acceptable Product

"Typical" Contract Types by Phase



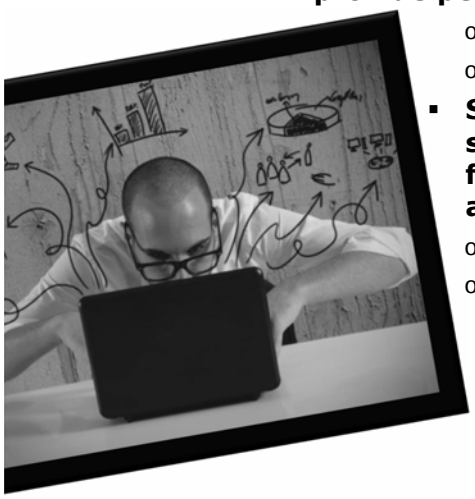
CPFF= Cost Plus Fixed Fee
CPAF= Cost Plus Award Fee

CPIF= Cost Plus Incentive Fee
FPIF= Fixed Price Incentive Firm

FFP = Firm Fixed Price
FP (EPA) = Fixed Price Economic Price Adjustment

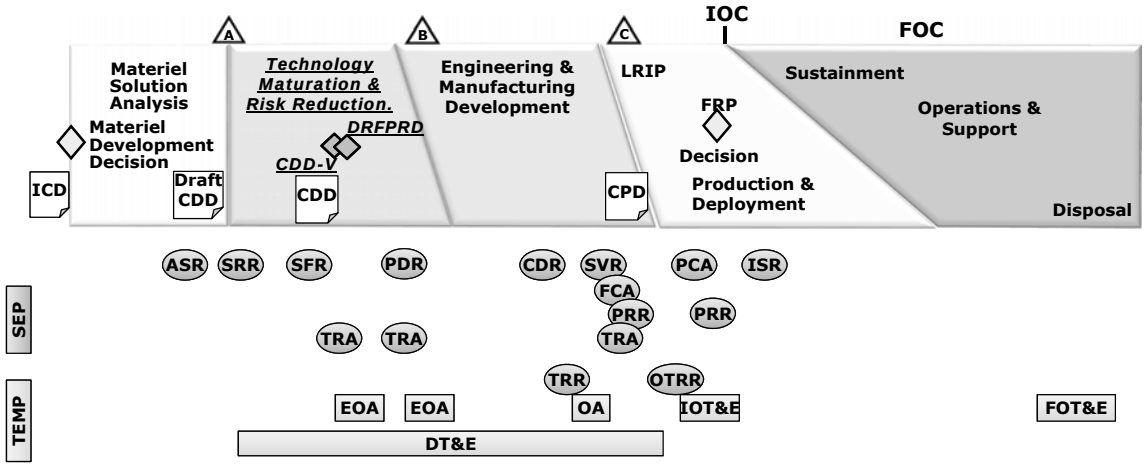
Technical

- **Systems Engineering—the overarching process that a program team applies to transition from a stated capability to an operationally effective and suitable system**
- **Test and Evaluation—process by which a system or components are exercised and results analyzed to provide performance-related information**
  - o Program/contractor systems engineers
  - o Developmental and Operational test communities



- **Supportability—includes design, technical support data, and maintenance procedures to facilitate detection, isolation, and timely repair and/or replacement of system anomalies**
  - o Program/contractor systems engineers
  - o Program/contractor logistic engineers

Technical Reviews and Testing

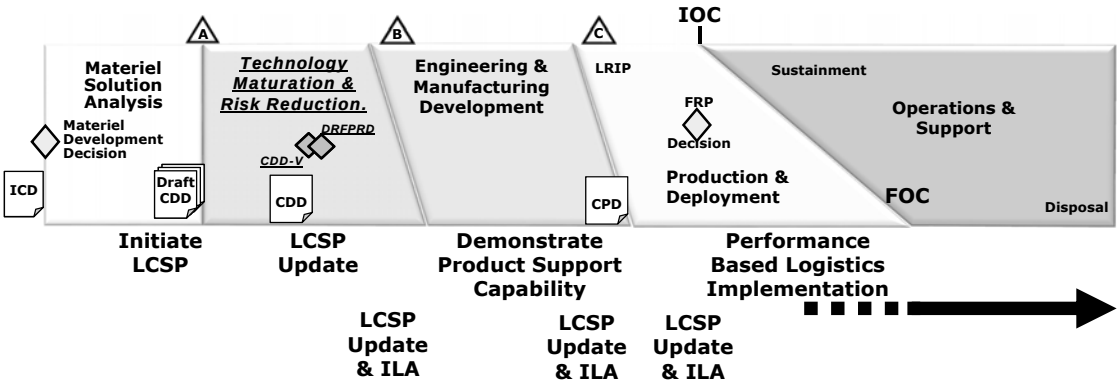


- Alternative Systems Review (ASR)
- Systems Requirements Review (SRR)
- System Functional Review (SFR)
- Preliminary Design Review (PDR)
- Critical Design Review (CDR)
- Test Readiness Review (TRR)
- System Verification Review (SVR)
- Functional Configuration Audit (FCA)
- Production Readiness Review (PRR)
- Operational Test Readiness Review (OTRR)
- Physical Configuration Audit (PCA)
- Technology Readiness Assessment (TRA)
- In-Service Review (ISR)
- Developmental Testing (DT)
- Early Operational Assessment (EOA)
- Operational Assessment (OA)
- Initial Operational Test & Evaluation (IOT&E)
- Follow on Operational Test and Evaluation (FOT&E)

Logistics/Sustainment

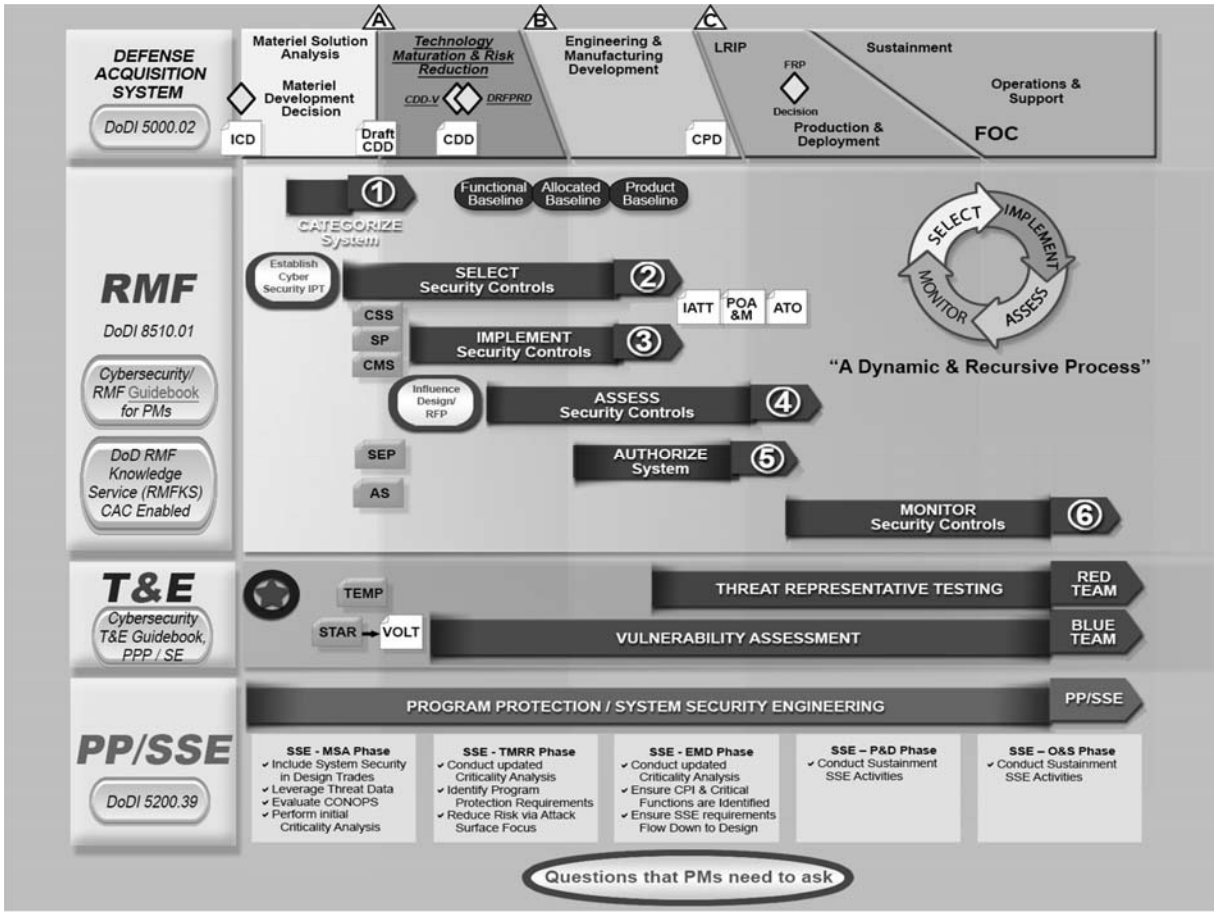
- **Technical and management activities conducted to ensure supportability implications are considered early and throughout the acquisition process to minimize support costs and to provide the user with the resources to sustain the system in the field.**
  - Evaluate product support capabilities
  - Develop, demonstrate, and implement product support strategy
    - Logistics footprint control
    - Reliability, Availability, and Maintainability
    - Training, spares, technical manuals, transportation
    - Performance Based Logistics (PBL) agreements
- **Major Defense Acquisition Programs are now required by law to have a Product Support Manager.**

Logistics/Sustainment Planning



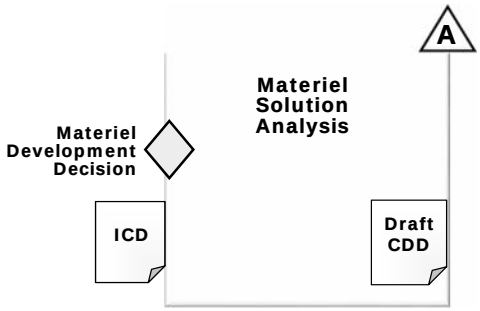
Performance Based Logistics (PBL), is the required DoD approach for product support. It allows us to manage program and system outcomes such as materiel availability and reliability as opposed to actions and transactions such as repairs and parts.

"a strategy for weapon system product support that employs the purchase of support as an integrated performance package designed to optimize system readiness. It meets performance goals for a weapon system through a support structure based on performance agreements with clear lines of authority and responsibility."



Materiel Solution Analysis

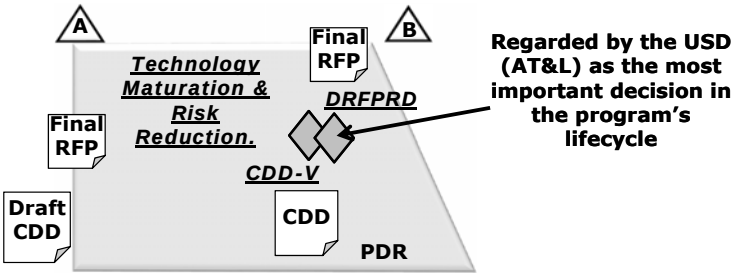
PURPOSE: to conduct the analysis and other activities needed to choose the concept for the product that will be acquired



- **ENTER:** Approved ICD, study guidance for conducting the AoA and an ***approved AoA plan***. AoA study guidance and AoA plan approval will be provided by CAPE for MDAPs.
- **ACTIVITIES:** ***Establish PM & PMO,*** Conduct AoA, user writes draft CDD, develop initial:
  - ***Acquisition Strategy***
  - ***Test & Evaluation Master Plan (TEMP)***
  - Systems Engineering Plan (SEP)
  - ***Life Cycle Sustainment Plan (LCSP)***
  - ***Program Protection Plan with Cyber Security Strategy annex***
  - Other program documentation as required
- **GUIDED BY:** ICD and AoA Plan
- **EXIT:** Completed the necessary analysis and activities to support a decision to proceed to the next decision point and desired phase in the acquisition process.

Technology Maturation and Risk Reduction

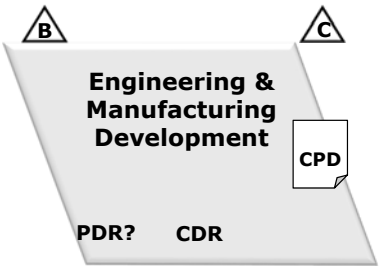
PURPOSE: to reduce technology, engineering, integration, and life cycle cost risk to the point that a decision to contract for EMD can be made with confidence in successful program execution for development, production, and sustainment



- **ENTER:** MDA approved materiel solution and Acquisition Strategy, initial major program documentation and funding in the FYDP
- **ACTIVITIES:** Competitive prototyping of critical subsystems, SE Trade-off analysis, develop contracting strategy, conduct ***CDD Validation,*** conduct Preliminary Design Review (PDR), conduct ***Development RFP Release Decision***, begin source selection for EMD
- **GUIDED BY:** Acquisition Strategy & Draft CDD/Approved CDD, SEP & TEMP
- **EXIT:** Demonstration that technology, engineering, integration, manufacturing, sustainment, and cost risks risk have been adequately mitigated to support a commitment to design for production, Validated capability requirements, full funding in the FYDP, and compliance with affordability goals for production and sustainment

Engineering and Manufacturing Development

PURPOSE: to develop, build, and test a product to verify that all operational and derived requirements have been met and to support production or deployment decisions



- **ENTER:** Adequate Risk Reduction; Approved Requirements; Full Funding in FYDP
- **ACTIVITIES:** Complete detailed design, system-level CDR, integrated testing, establish product baseline, demonstrate manufacturing processes and supportability
- **GUIDED BY:** CDD, Acquisition Strategy, SEP & TEMP
- **EXIT:**

  (1) the design is stable;

  (2) the system meets validated capability requirements demonstrated by developmental and initial operational testing as required in the TEMP;

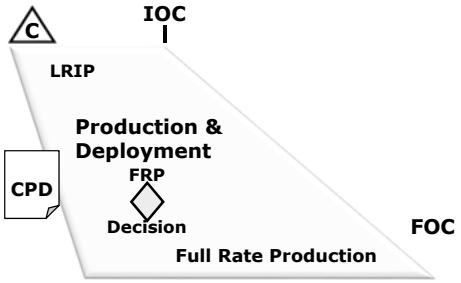
  (3) manufacturing processes have been effectively demonstrated and are under control;

  (4) industrial production capabilities are reasonably available; and

  (5) the system has met or exceeds all directed EMD Phase exit criteria and Milestone C entrance criteria

Production and Deployment

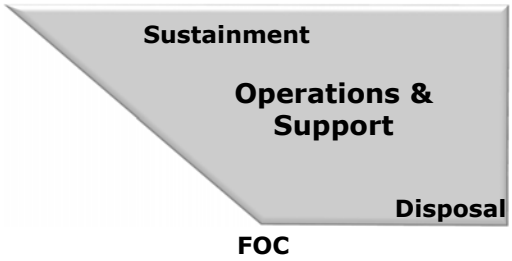
PURPOSE: to produce and deliver requirements-compliant products to receiving military organizations



- **ENTER:** Acceptable performance in DT & OA; mature software; no significant manufacturing risks; approved CPD; acceptable interoperability and operational supportability; demonstration of affordability; fully funded
- **ACTIVITIES:** Low Rate Initial Production, IOT&E, LFT&E (If Required) and interoperability testing of production-representative articles; Full-Rate Production Decision; fielding and support of fielded systems; IOC/FOC
- **GUIDED BY:** CPD, TEMP, SEP, LCSP
- **EXIT: Full operational capability; deployment complete**

Operations and Support

PURPOSE: Execute a support program that meets materiel readiness and operational support performance requirements, and sustains the system in the most cost-effective manner over its total life cycle.



- **ENTER:** Approved CPD; approved LCSP; successful FRP Decision
- **ACTIVITIES:** LCSP implementation; Performance-Based Life-Cycle Product Support (PBL) implementation, and management; initiate system modifications as necessary; continuing reviews of sustainment strategies, Demilitarize and dispose of systems IAW legal and regulatory requirements, particularly environmental considerations and explosives safety
- **GUIDED BY:** CPD/Acquisition Strategy/LCSP

Warm Up Exercise

For each of the following situations, determine where on the acquisition life cycle model would recommend the Milestone Decision Authority (MDA) authorize entry into the defense acquisition management framework?

1. An Initial Capabilities Document (ICD) was validated and approved for a joint war fighting capability to intercept and attack ballistic missile reentry vehicles in mid-course, prior to reentering the earth's atmosphere. The ICD identified several possible materiel approaches to provide the required capability including an air launched missile interceptor. Market research determined that the technology is feasible, but the various possibilities need to be analyzed to determine the best missile and launch platforms before the appropriate technology can be demonstrated. The MDA also wants to designate a lead DoD Component for this joint war fighting system, needs a strategy for rapid fielding using evolutionary acquisition, and wants to encourage maximum innovation and competition for the best system(s) from private industry. CAPE has issued AoA study guidance and approved an AoA study plan.

2. Senior leaders in the U.S. Army are anticipating protracted times of constrained budgets and limited opportunities to train. Army leaders are looking for technology solutions that will greatly improve accuracy when firing side arms with limited training. There is a recently approved CPD leveraging an already existing ICD for Soldier small-arms capability needs. The CPD requires a new Soldier side-arm solution that includes an integrated targeting LASER with significantly improved first shot accuracy. Multiple commercial vendors offer pistols with integrated targeting LASERs; three vendors in particular have existing contracts and running productions lines supplying the U.S. Marine Corps and U.S. Special Operations Forces. Field evaluations from the Marines and SOF combat units indicate effectiveness and suitability of the firearms, particularly accuracy, which meets the CPD thresholds. The program has full procurement funding.

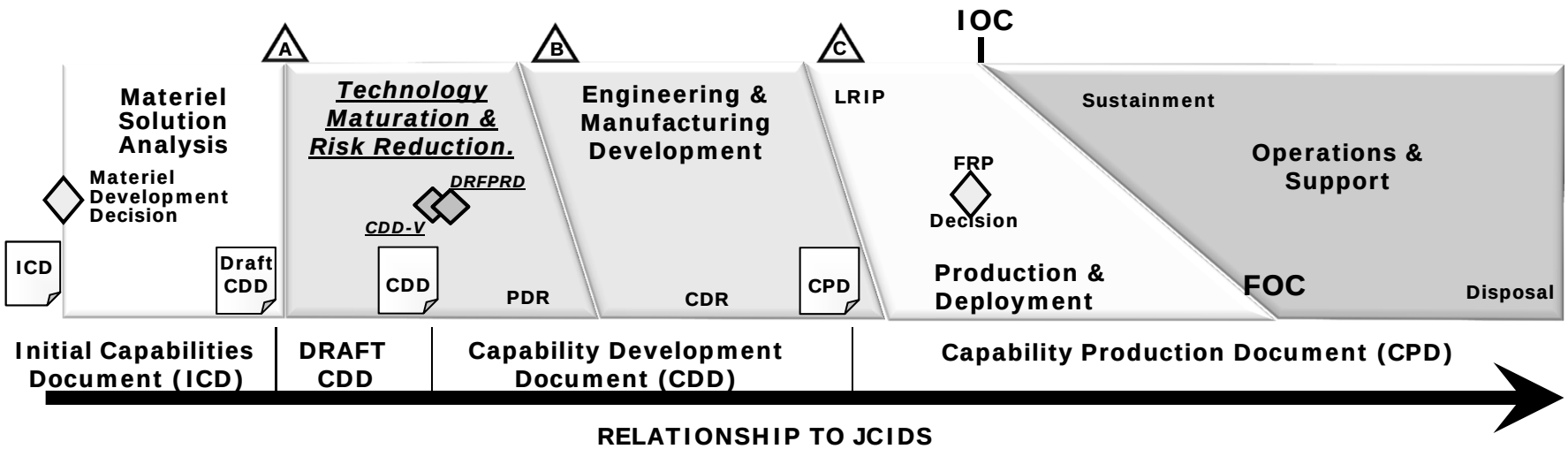
3. An ICD has been validated and approved for a capability to intercept and attack ballistic missile reentry vehicles in mid-course, prior to reentering the earth's atmosphere. Air Force will be lead service to develop this capability. An analysis of alternatives and an acquisition strategy have been completed and the Air Force has selected as the best system a laboratory proposal for a laser mounted on an existing airplane. Funding for the effort was included in the latest update to the FYDP. The concept is promising, however, the technology has not been matured and there are significant performance risks. The user has provided a draft CDD based on the ICD.

4. A Navy Lab has developed a protective eye shield/mask that will guard the wearer's eyes against the full spectrum of current lasers directed from any angle. The Navy Lab has coordinated with the users, who have produced an ICD and CDD that have both been validated and approved by the Chief of Naval Operations. The Navy Acquisition Executive agreed to fully support this initiative in the upcoming budget review, and has identified specific offsets in other programs to provide the funding. The technology appears to be mature and technical risks are assessed as low. However, the system has yet to be tested outside of the lab. It also has not been integrated with other components of a helmet system.

The Defense Acquisition Management System

- The Materiel Development Decision precedes entry into any phase of the acquisition management system
- Entrance Criteria met before entering phase
- Evolutionary Acquisition or Single Step to Full Capability

Model 1: Hardware Intensive Program



▪ PDR: Preliminary Design Review ▪ CDR: Critical Design Review ▪ CDD-V: CDD Validation	▪ LRIP: Low Rate Initial Production ▪ FRP: Full Rate Production ▪ DRFPRD: Development Request For Proposals Release Decision	▪ IOC: Initial Operational Capability ▪ FOC: Full Operational Capability

Capstone Exercise (to be completed and briefed Friday) –

Background

Firebird II unmanned air vehicles (UAV's) have reached FOC, and have been successfully carrying out military operations around the world. The survivability enhancements provided in Firebird II have reduced the loss rate from heat-seeking shoulder-launched missiles to less than 10% per engagement. However, because of deeper defense budget cuts and further consolidation, the need has emerged for Firebird to provide more persistent Intelligence, Surveillance, and Reconnaissance (ISR) capability. As a result, the Services want to increase the Firebird loiter time from 3 hrs to 4.5/6.0 hrs (threshold/objective). This increase in loiter time is to be provided while achieving the original Firebird II requirement for range of 250 KM/300 KM (threshold/objective).

The next increment, dubbed "Firebird III", is planned to address the capability needs and include engineering changes to address reliability degraders. The MDA has approved the Materiel Development Decision for Firebird III and an AoA has been completed. The following new requirements have been included in the draft CDD for Firebird III:

DRAFT REQUIREMENTS FOR FIREBIRD III

1. Firebird III will have a loiter capability of 4.5/6.0 hrs (threshold/objective). This is a Key Performance Parameter (KPP).

2. Firebird III will have a range of 250/300 KM (threshold/objective). This is a Key Performance Parameter (KPP).

3. Firebird III will provide Link 17 capability for real-time transfer of compressed digital video intelligence to the DoD Information Network (DoDIN).

All other requirements from the Firebird II CDD remain unchanged. You can assume that the program will be fully funded in the FYDP in time for the next milestone and the CDD will be approved in time for a DRFPRD.

Situation

Ms. Connie Smith, former contracting officer for the Firebird program, has been promoted and is the newly appointed interim Program Manager for Firebird III. She has asked your team to develop a program structure chart for the Acquisition Strategy. She has provided the following information:

- Firebird III will be a joint, ACAT II program with the Army as the lead service.
- Initial Operational Capability (IOC) objective date is 42 months from program initiation. IOC threshold date is 48 months from program initiation (Milestone B).

The user's requirement for IOC is 2 operational Firebird III systems (2 ground stations and 8 UAVs).

- Retrofit of 400 Firebird air vehicles is required to meet FOC for all the military services combined.

Responses to an RFI have provided the Program Manager with several possible acquisition strategy alternatives. She wants to explore three different acquisition strategy approaches:

Approach 1. Two contractors responding to the Request for Information have indicated that they have integrated a more fuel efficient, lightweight engine into a commercial variant of the Firebird. The contractors have already successfully flown these prototype Firebird air vehicles using this engine which indicates the potential to meet the increased loiter time and range requirements. However, the prototypes must be further refined and developed before production representative units suitable for Operational Testing can be fully designed, integrated, and built.

Approach 2. Recent advances in lightweight material technology research look promising. MIT has been working on a new material, called Litex that may be suitable for aircraft skins due to its combination of extreme light weight and strength. The Air Force Research Laboratory has published a white paper describing potential future applications of this technology in UAVs. According to the paper, the Firebird airframe could be retrofitted with Litex to meet the increased loiter time and range requirements if this technology pans out. However, it also states that Litex is not yet mature enough to use in aircraft. Six months of development and testing is necessary to determine durability and temperature limits before the material is ready for integration into aircraft and actually flown at representative altitudes and airborne profiles. Several U.S. contractors have the necessary technical and manufacturing capabilities to apply this technology to the Firebird.

Approach 3. Mannheim Technologies, a small German company, has proposed adding a "probe and drogue type" aerial refueling capability to Firebird. According to Mannheim, UAV to UAV refueling is feasible using GPS technology, automated flight controls, and optical tracking systems to approach, link-up, and complete the refueling procedure. If successful, the ability to refuel would significantly increase loiter time and range of the Firebird without the need to change the engine or airframe materials. In addition, it may be possible to provide more persistent ISR capabilities with fewer Firebird UAV's. Although DARPA and other U.S. defense contractors are working on UAV to UAV refueling as well, significant effort remains before the technology is considered mature and it has yet to be demonstrated in flight test.

Note to Students: All the situations allow competitive acquisition and two of the approaches should consider using use competitive prototyping in TMRR. In order to do that, the text mentions commercial variants of the Firebird. These are demilitarized versions (without weapons, some sensors and secure data links) that are sold internationally for use by border patrols, coast guard, fisheries and wildlife managers, conservationists, police and scientific communities. The variants allow the situation that companies other than CyboRaptor have access to Firebirds to develop prototypes/EDMs with the required capabilities.

Exercise Introduction

One team member will serve as the IPT leader. The IPT leader will be responsible for guiding the efforts of the other team members and for briefing the program structure chart. The other team members will assist the IPT leader by providing functional area expertise (contracting, systems engineering, test and evaluation, logistics, and financial management). Prior to your IPT meeting on Friday, all team members should review the assigned approach and consider the questions related to each functional area in the development of the program structure chart. No more than 2 hrs will be provided Friday morning to complete the program structure chart, so advance research and coordination with team members will be necessary. Remember to include activities related to all Firebird III changes. You may leverage and expand upon work completed in previous lessons and exercises.

In addition, the Program Manager needs to ensure that we have addressed concerns expressed by the Program Executive Officer. Each team will be assigned one of the areas of concern to address in detail as part of the exercise briefing.

Assignment 1:

Your team will be assigned to explore one of the above approaches. You are now in FY-1 of the Firebird III effort. Assume that it will be at least three months before your Acquisition Strategy will be approved. Based on the information above for your assigned approach, determine in your team:

- At what point in the life cycle will your program enter systems acquisition?
- What phases and work efforts will be included?

Lay out on a notional timeline the acquisition life cycle phases, work efforts, and major milestone/program decision reviews needed to execute and oversee your program. Be prepared to present your timeline to the class, including the rationale for your decisions and any assumptions your team made (as part of your Friday briefing). Do not go on to Assignment 2 until after you have presented your timeline to one of the instructors and received the instructor's approval to proceed. Your team should review Assignment 1 with an instructor Thursday morning at the latest.

Assignment 2:

Using the timeline you developed, fill out the rest of the elements of the program structure chart for your approach. It may be helpful to complete the program structure chart through a series of steps for each phase of the program, as outlined below.

If necessary, make assumptions about the technology, the operational requirements, and the political and economic situation in order to complete your program structure chart. List your supporting assumptions on butcher paper as you go. The instructor may change or add to those assumptions before you complete your acquisition strategy.

The IPT leader will present to the class a 15-minute overview of your program structure chart, your assumptions, and the rationale for your decisions.

Use the following questions to help frame your team's thinking as you put together the details of your acquisition strategy.

Step 1 - Programmatic Issues:
Consider overall programmatic issues as you begin developing your acquisition strategy:

- What are the major program risks regarding cost, schedule, and performance?
- What can you do to mitigate those risks?
- How much concurrency will be in your acquisition strategy? You might save time by overlapping activities, but you might also increase risk.
- What new environmental issues, if any, might need to be addressed?
- Is international cooperative development feasible?
- When will initial operational capability (IOC) be achieved?

Step 2 - Contracting Issues:
Consider contractual issues for your acquisition strategy:

- How many contractors will develop and produce Firebird III in each phase of your acquisition strategy?
- How will you address competition?
- What types of contracts will be used in each phase of your acquisition strategy?
- What are your planned dates for RFP release(s) and contract award(s)?

Step 3 - Technical Management Issues:
Determine how you will address technical management aspects of your acquisition strategy:

- Technical reviews and audits: which ones, when, and how many?
- How can modeling and simulation be used to support the program?
- Will interoperability with other systems be affected? The increment cannot disrupt any interchanges required between Firebird and other systems.
- To what extent will you use open systems architecture? Why?
- What types of testing will be conducted, and when it will take place? How will interoperability and reliability upgrades be tested?

Step 4 - Logistics Issues:
Consider how you will address supportability aspects of your acquisition strategy.

- What new supportability issues arise in the transition from Firebird II to Firebird III?
- What supportability planning needs to occur and when?
- What testing needs to be done to confirm the required reliability is achieved prior to fielding? When should the testing be done?

- How will performance based life cycle product support be performed?

Step 5 - Production Issues:
Consider the articles required for conducting various tests, including both LRIP and full rate production:

- What quantities of items will be produced?
- What is the purpose of articles produced?
- When will they be delivered?

Step 6 - Financial Management:
Address financial management aspects of your acquisition strategy.

- What appropriation(s) will be used during each phase of your program? Indicate them at the bottom of your program structure chart.
- What impacts, if any, will the end or beginning of a fiscal year have on your funding strategy?
- How will you deal with the PPBE process, including getting initial funding?

Note: The PMO and the user agreed to the following life cycle cost objectives (in the current base fiscal year). These costs reflect agreed-to affordability goals:

- RD&TE: $300M
- Procurement: $410M based on the following estimates:
  - 400 air vehicle retrofit kits @ $1M each = $400M
  - 100 ground station retrofit kits @$100K each = $10M
- O&M: $1.2B over 20 years of system life.

If necessary, make assumptions concerning the costs of your program.

Program Executive Officer - Areas of Concern:

Also address these areas of concern for the PEO.

Technology Maturity - What specific actions do you intend to take during Technology Maturation and Risk Reduction phase to ensure that your program is ready for Engineering & Manufacturing Development phase?

Schedule Risk - You may be able to compress your schedule if you plan to conduct some activities concurrently (e.g., development and initial production, DT and OT, design reviews, etc.). How much concurrency (overlapping activities) is appropriate for your strategy? What specific efforts might be good candidates for a concurrent approach?

Test Efficiency - How does your strategy address integrated testing (DT/OT)? What actions are necessary now and throughout your strategy to ensure we take full advantage of integrated testing? How would you use modeling and simulation?

Competition - How does your strategy address competition in each phase? What are some actions we can take as part of the initial effort to enable greater competition in subsequent phases? Are there opportunities to compete at a subsystem level and how would we plan for that?

Operational Suitability - How does your strategy address reliability and maintainability? What specific actions/efforts should we consider in each phase to ensure we develop a suitable system? How will we know if we are on track?

Logistics Support Strategy - What kind of PBL strategy should we pursue? What actions would we need to take in the initial phase of work to facilitate this strategy for deployment?

Assignment 3:

In this assignment, the IPT leader (with limited assistance of other team members) will present to the class a 15-minute overview of your program structure chart, your assumptions, and the rationale for your decisions. The presentation of your acquisition program chart should address at a minimum:

- Key milestones, reviews and phases
- Number of contractors in each phase and your rationale regarding competition
- Contract types
- RFP release and contract award dates
- Technical reviews and audits
- Production deliverables
- Major test events
- IOC date
- Appropriation category of funding required for each phase of the acquisition
- Logistics/life cycle sustainment events and deliverables

Be prepared to discuss the major risks regarding cost, schedule, and performance and what you can do to mitigate those risks. The Program Manager will be most interested in what you consider to be your *top technical risk*.

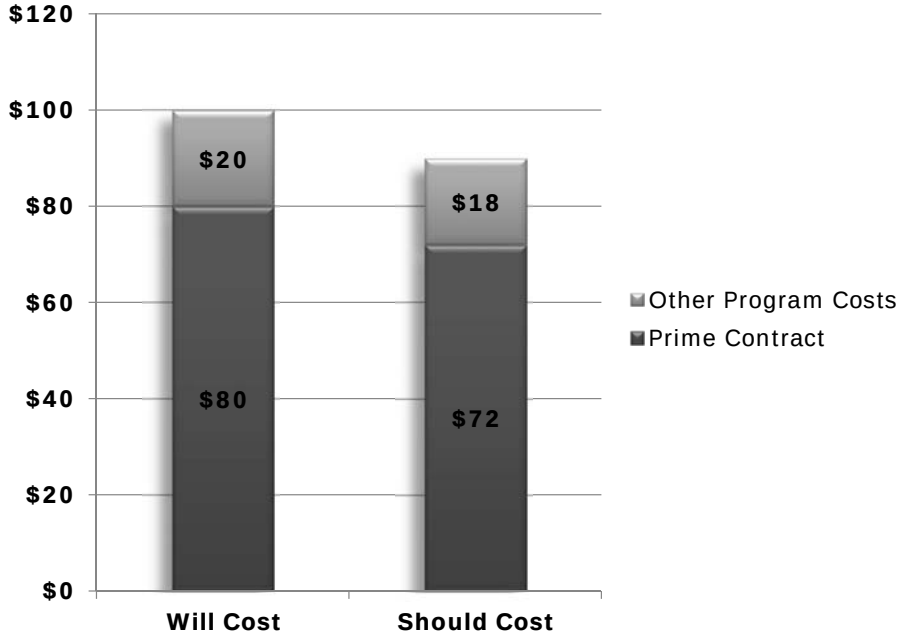
You will also be asked to evaluate and question the acquisition strategies presented by the other teams and provide constructive feedback.

Impact Statements and Reclamas

- **Ensure statements are *consistent* with what has already been put in writing (i.e. budget exhibits, acquisition strategy, etc..)**
- **GENERAL GUIDELINES: Address *operational* and program impacts; provide specific, credible impacts; use simple language; and be prepared to follow through with programmatic changes cited in the impact statement.**
  - FOR RECLAMAS: Be *concise*; give *specific answers* that address the reason for the cut; and challenge facts, providing additional or correct information.
- **WHAT NOT TO DO:**
  - Say your program is unexecutable for a small (e.g. 5%) cut
  - Not respond
  - Flag wave

Will Cost Vs. Should Cost Example

"They (Program Managers) should be scrutinizing every element of program cost, …in short, executing to what the program should cost."



LESSON ASSIGNMENT SHEET

Lesson Number Exercise 2.2

Lesson Title Source Selection Planning

Lesson Time 2 hours

Terminal and Enabling Learning Objectives

TLO		**Develop portions of a source selection plan, including source selection criteria**
	ELO	Identify how the Government communicates performance requirements in solicitations.
	ELO	Identify the role of various IPT members in developing the solicitation.
	ELO	Identify the purpose of evaluation criteria and how the criteria are developed.
	ELO	Develop evaluation criteria in a source selection.
	ELO	Identify methods of pre-solicitation communication with defense contractors.

Assignments Review the following ACQ 202 CBT Lesson Summary:

- Lesson 3.1, Source Selection Process

Estimated Student Preparation Time 10 minutes

Assessment Class participation; oral presentation

Related Lessons

- CBT Lesson 2.8, RFP Preparation, Part I
- CBT Lesson 2.9, RFP Preparation, Part II
- CBT Lesson 3.1, Source Selection

Self Study References FAR Part 15

Why Competition is Important

- **1974: Hughes Missile Systems was sole designer, developer & producer of Navy's AIM-54, Phoenix Missile**
- **Early 1980's: Production/unit cost were approx. $1M**
- **Mid 80's: DoD developed 2nd source after full & open competition**
  - Raytheon won 2nd source development contract
- **Late 80's: Navy held limited competition**
  - 1 contract to win minimum production quantity to maintain production line
  - 1 contract to win majority production quantity
  - Raytheon won majority; Hughes won minimum production quantity
- **1 year later, Navy held head-to-head and Hughes won.**
  - Hughes' production per unit cost was $499K
  - Competition drove cost down by just over 50%

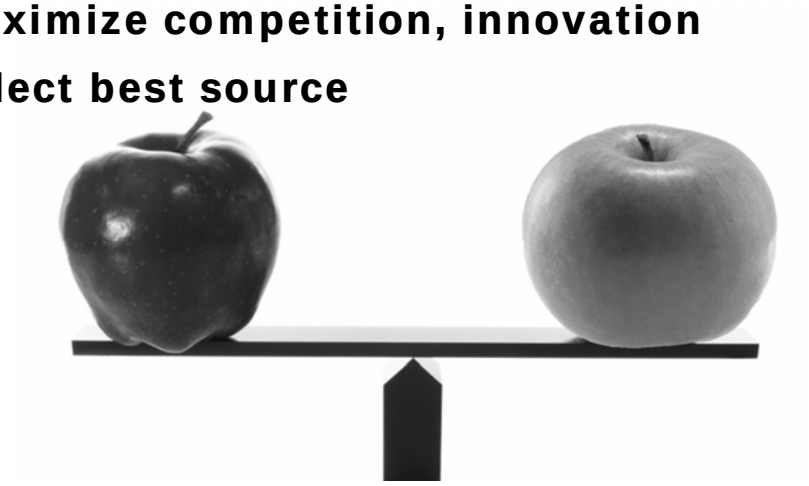
Why Competition is Important

- **2010: The adjusted unit procurement cost for the Littoral Combat Ship was $538 million**
- **Navy encouraged vigorous head-to-head competition between Austal USA and Lockheed Martin**
- **2011: DON signed contracts for $440 million per sea frame**
- **March 2012: Hon Ray Mabus, Secretary of the Navy stated:**
  - **"The award represents a unique and valuable opportunity to lock in the benefits of competition and provide needed ships to our fleet in a timely and extraordinarily cost-effective manner."**
  - **According to Mabus, as a general rule, competition can reduce procurement cost between 15 and 18 percent, but savings can be even greater**
- **Competition improves contractor performance, curbs fraud, and promotes accountability**

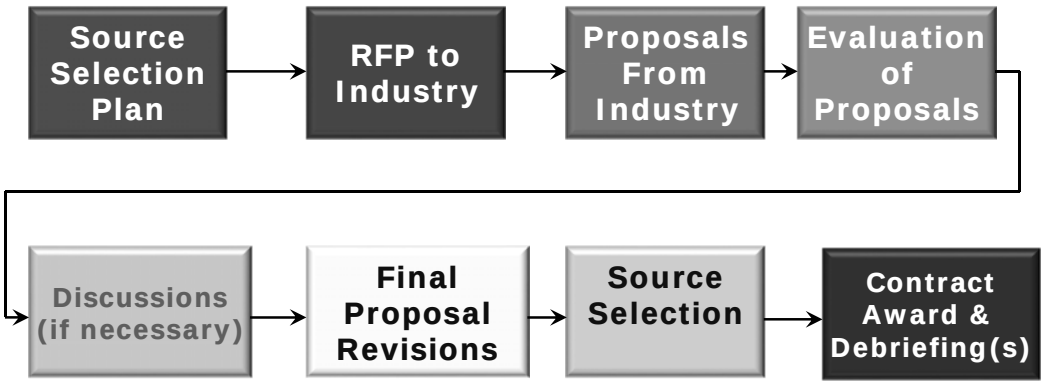
Source Selection

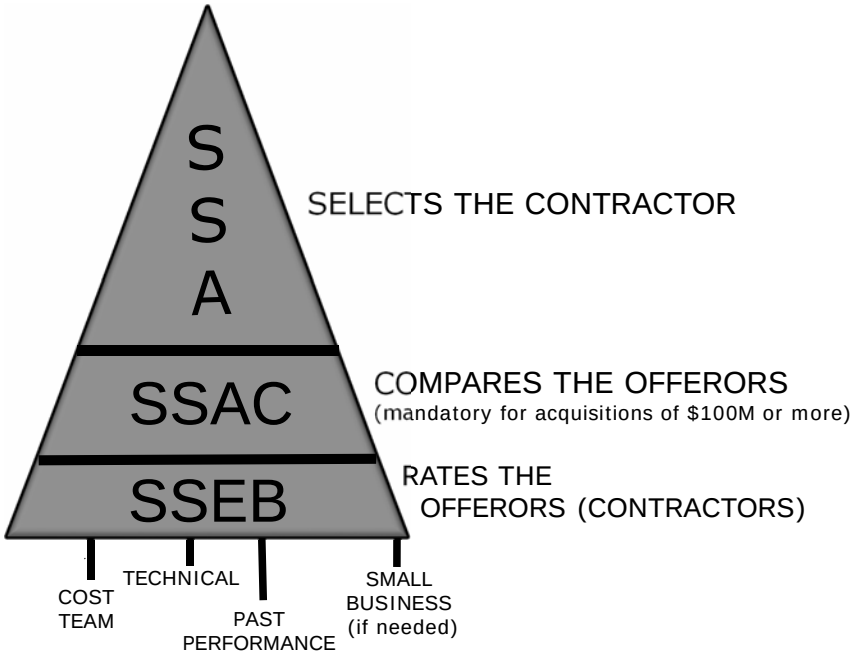
Purpose:

- **Provide a structured, fair, impartial evaluation of offerors**
- **Maximize competition, innovation**
- **Select best source**



Nominal Source Selection Process





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DoD Source Selection Procedures, 1 April 2016 (No Foolin')

Purpose

- **Uniform procedures across DoD**
- **Simplify source selection process**
- **Require standardized rating criteria and descriptions for technical and past performance factors**
- **Require appointment of SSAC on source selections valued over $100M**

Source Selection Plan

- Details all aspects of source selection process
- Key elements:
  - Organization / Personnel
  - Conduct
  - Criteria for Proposal Evaluation
- Prepared by Contracting Officer / IPT
- Approved by SSA

PM / Rqmts Office Roles & Responsibilities

- Ensure technical requirements are approved and stable
- Establish technical specifications
- Develop SOW, SOO or PWS
- Allocate Resources to support SSP
- Assist in establishing SST
- Assist in development of evaluation criteria

Pre-RFP Communication with Industry

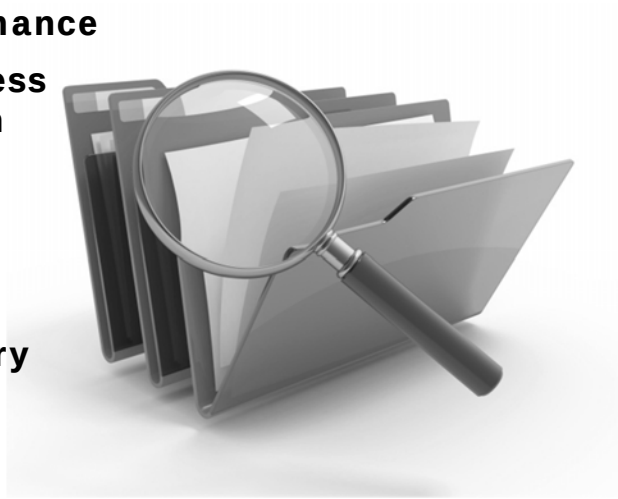
- Market Research
- Industry Day
- Request For Information (RFI)
- Draft Request For Proposal

Communicating Requirements

- Request For Proposal
  - SOO
  - PWS
  - SOW
  - System Spec
  - CDD/CPD (some organizations)

Evaluation Factors / Subfactors

- **Meaningful discrimination among offerors**
- **Examples:**
  - o **Cost**
  - o **Technical**
  - o **Past Performance**
  - o **Small Business Participation (if needed)**
- **Tailored to the acquisition**
- **Level of detail, number will vary (minimize)**



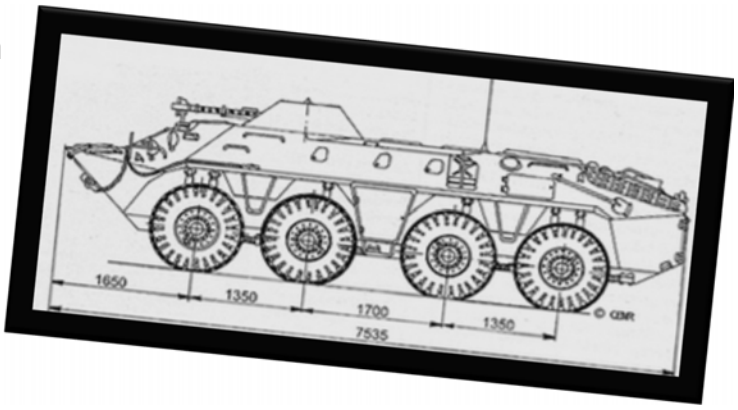
Evaluation Factor / Subfactors Example

Factor:

- Technical

Subfactors:

- Weapon Accuracy
- Range
- IED Protection

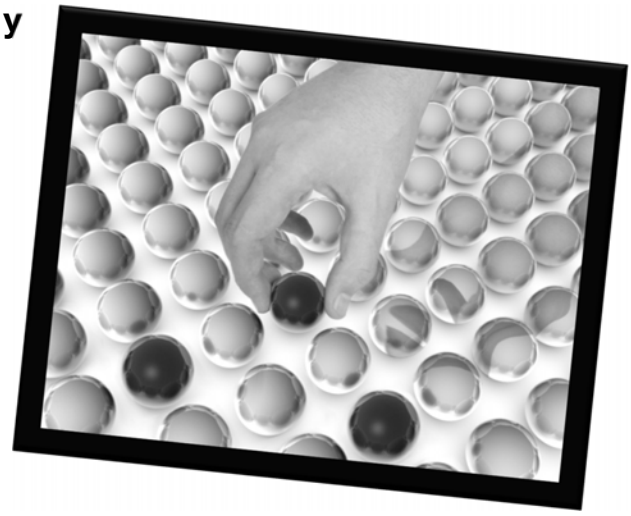


Evaluation Factors / Subfactors

- **Choose carefully**

  Will this factor help me select a winner by discriminating from the less capable offerors?

- **Use sparingly**



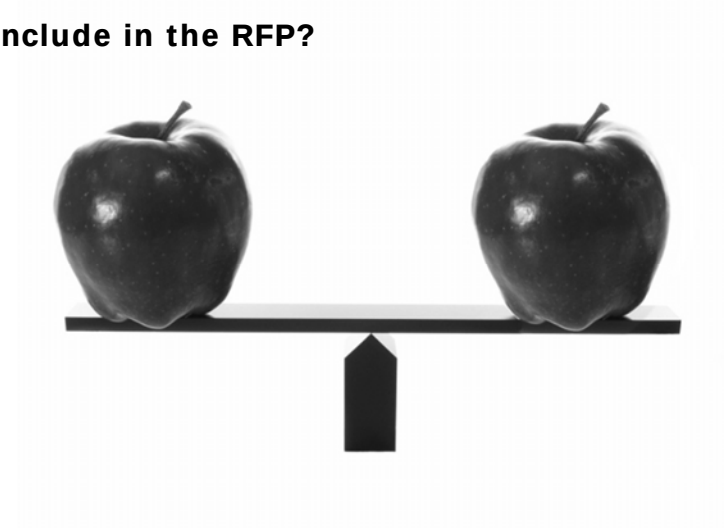
Evaluation Factors / Subfactors (continued)

- **Basis for contractor selection**
- **Ensure contractor:**
  - o Can perform work
  - o Understands requirement
- **Included in the RFP (Section M)**

Factor Relative Importance

"Numerical or percentage weighting of the relative importance of evaluation factors and sub-factors shall not be used."

- How is it determined?
- Do we include in the RFP?



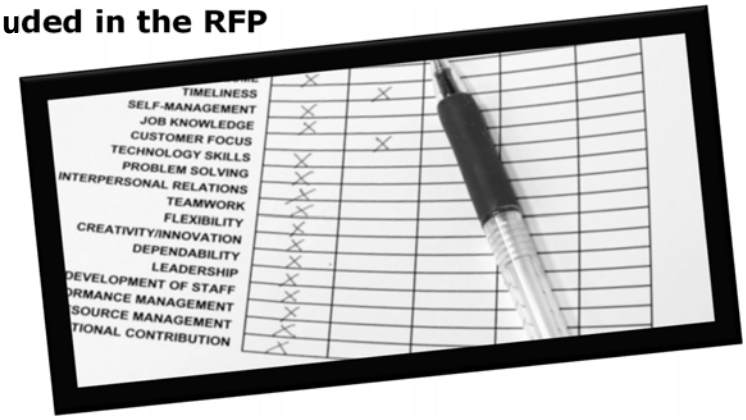
Factor Relative Importance

Example

"The Technical area is significantly more important than Cost, which is more important than Past Performance."

Evaluation Rating Guidelines

- Developed for each factor / subfactor
- Used to determine how well a proposal meets a factor / subfactor
- Can use words and / or colors
- Must be clearly defined & understood by SSEB
- Not included in the RFP



Standardized Source Selection Evaluation Ratings

Table 1. Combined Technical/Risk Ratings

Color	Rating	Description
Blue	Outstanding	Proposal indicates an exceptional approach and understanding of the requirements and contains multiple strengths, and risk of unsuccessful performance is low.
Purple	Good	Proposal indicates a thorough approach and understanding of the requirements and contains at least one strength, and risk of unsuccessful performance is low to moderate.
Green	Acceptable	Proposal meets requirements and indicates an adequate approach and understanding of the requirements, and risk of unsuccessful performance is no worse than moderate.
Yellow	Marginal	Proposal has not demonstrated an adequate approach and understanding of the requirements, and/or risk of unsuccessful performance is high.
Red	Unacceptable	Proposal does not meet requirements of the solicitation, and thus, contains one or more deficiencies, and/or risk of unsuccessful performance is unacceptable. Proposal is **unawardable.**

Source Selection Criteria Summary

- **Evaluation Factors / Subfactors**
  - e.g. Quality/Reliability
- **Factor / Subfactor Importance**
  - e.g. Quality is more important than Cost
- **Evaluation Standard & Rating Example**

Subfactor	Standard	Rating
MTBCF	180 hrs ≤ MTBCF	Blue
	165 ≤ MTBCF < 180	Purple
	150 ≤ MTBCF < 165	Green
	135 ≤ MTBCF < 150	Yellow
	MTBCF < 135 hrs	Red

Best Value Continuum

Greater — **Importance of Price** — **Lesser**

Lesser — **Importance of non-Price or Cost Factors** — **Greater**

FAR Part 15

	Lowest Price/ Technically Acceptable (LPTA)	Value Adjusted Total Evaluated Price (VATEP)	Combination Approach	Subjective Tradeoff
	Non-Price Factor(s): Pass/Fail Only Price Factor: Lowest Price	Bidders receive a price evaluation credit for achieving defined, (preferably measurable) performance beyond threshold values	-Some factors pass/fail -Other factors used in tradeoff For example-- Technical: Pass/Fail; Tradeoff only allowed between Past Perf. and Price	Can award to offer that is other than lowest price or other than highest rated on non-price factors. Tradeoff is among price and non-price factors.
Basis for Award	**No Tradeoff** *Lowest Price that is Technically Acceptable ["Pass" on all non-price factors].*	**Tradeoff** *Limited to subjective non-VATEP evaluated factors only. Must document basis for award to other than lowest evaluated price.*	**Tradeoff** *Limited to NON-pass/fail factors only. Must document basis for award to other than lowest price or other than highest rated on non-price factors.*	**Tradeoff** *All factors in tradeoff. Must document basis for award to other than lowest price or other than highest rated on non-price factors.*

"Best value" means the expected outcome of an acquisition that, in the Government's estimation, provides the greatest overall benefit in response to the requirement." FAR 2.101

Background:

The Army Acquisition Executive has granted Milestone A approval for Firebird II. A Program Management Office (PMO) has been fully staffed to support this program; you and your IPT have been assigned to carryout the effort.

We are now in the Technology Maturation and Risk Reduction phase. In accordance with the acquisition strategy, contracts were awarded through full and open competition to two contractors to develop competitive prototypes for the Firebird II. The two contractors will compete with their prototypes in developmental testing and a fly-off just before Milestone B. The fly-off will be followed by a down-select to one contractor. The competitors will be given a final Request For Proposals (RFP) immediately following the Development RFP Release Decision (DRFPRD). The successful competitor will then execute the program through the Engineering and Manufacturing Development phase.

A team has been assembled to write a Source Selection Plan (SSP) including the draft RFP addressing the down-select. This exercise will focus on that SSP.

One of the factors to be evaluated at the down-select is technical performance. The Firebird II source selection team has already developed technical subfactors based on the draft CDD and a performance work statement. Those subfactors are: range, launch, survivability , Mean Time to Repair (MTTR), weapons accuracy and Mean Time Between Critical failure (MTBCF).

Assignment:

1. For each of the six technical subfactors, determine their relative importance to each other. Remember that subfactors can have equal importance, or one subfactor can be more important, slightly more important, or significantly more important than another subfactor. The user has determined that survivability is the most important requirement for Firebird II.

2. Your instructor will assign one or more of the subfactors (on the following pages) to your team for analysis. Develop a clear set of standards for evaluating the subfactor(s) assigned to your team, using a rating system where:

Standardized Source Selection Evaluation Ratings

Table 1. Combined Technical/Risk Ratings

Color	Rating	Description
Blue	Outstanding	Proposal indicates an exceptional approach and understanding of the requirements and contains multiple strengths, and risk of unsuccessful performance is low.
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Red	Unacceptable	Proposal does not meet requirements of the solicitation, and thus, contains one or more deficiencies, and/or risk of unsuccessful performance is unacceptable. Proposal is **unawardable.**

For your subfactor, determine the standard based on the rating definitions above. The subfactors are based on the draft CDD parameters (shown on the next page), so refer to the Firebird II CDD as necessary. Use the subfactor table example to display your results. Be prepared to present your standards to the class**.**

Note that numerical standards are only one portion of subfactor evaluation. The source selection plan will also address how to evaluate risk at for each subfactor to arrive at a final color rating.

Also note that red is considered unawardable. In other words the performance is so bad that you would not consider awarding to that contractor. Use a table to depict your answer.

Subfactor	Standard	Rating
		Blue
		Purple
		Green
		Yellow
		Red

DRAFT FIREBIRD II CDD PARAMETERS

NOTE: These values come from the CDD. KPPs must be met by the Full Rate Production Decision in response to the Capability Production Document (CPD). KPPs and other performance values in the CPD will be decided by the user prior to MS C.

1. Range (KPP):

   Threshold: The vehicle must be able to fly out to 250 KM and return to base.
   Objective: The vehicle must be able to fly out to 300 KM and return to base.

2. Launch:

   Threshold: The UAV must launch from a stationary mobile launcher unit and be safely airborne within a distance of 30 feet.
   Objective: The UAV must launch from a stationary mobile launcher unit and be safely airborne within a distance of 25 feet.

3. Survivability (KPP):

   Threshold/Objective: The UAV must have a probability of survival against shoulder-launched heat-seeking missiles of at least 90%.

4. Mean Time to Repair (MTTR) for the UAV must be no more than:

   Threshold: 3 hours
   Objective: 2.5 hours

5. Weapons Accuracy: (KPP)

   Threshold: 10M Circular Error Probable (CEP)
   Objective: 5 M Circular Error Probable (CEP)

   Note: CEP, the circular error of probability, refers to the radius around the target within which the munitions must fall 50% of the time.

6. Mean Time Between Critical Failure (MTBCF) for the UAV must be no less than:

   Threshold: 150 hours
   Objective: 200 hours

LESSON ASSIGNMENT SHEET

Lesson Number Exercise 2.3

Lesson Title Systems Engineering

Lesson Time 1 hour

Terminal and Enabling Learning Objectives

TLO		**Apply the iterative SE steps to develop outputs of the systems engineering process in order to verify they meet a given requirement**
	ELO	Given a summary Capability Development Document (CDD) and a system concept, determine whether the concept addresses all user requirements.
	ELO	Identify the overall purpose of the systems engineering process
	ELO	Identify the technical processes that make up the overall systems engineering process
	ELO	Identify the technical management processes used to control and manage the overall systems engineering process
	ELO	Identify the main inputs and outputs of the overall systems engineering process
	ELO	Given an acquisition scenario within an IPT environment, develop and present selected outputs of the systems engineering process steps.

Assignments Review the following ACQ 202 CBT Lesson Summary:

- Lesson 3.2, Technical Risk Management
- Lesson 3.3 Design for Supportability, Trade Off Analysis
- Lesson 3.4 Software Design
- Lesson 4.5 Reviews, Simulations and Test
- Lesson 4.9 Operational and Live Fire Testing

Estimated Student Preparation Time 45 minutes

Assessment Class participation; oral presentation

Related Lessons	CBT Lessons 3.2, Technical Risk Management, 3.3 Design for Supportability, Trade Off Analysis, 3.4 Software Design, 4.5 Reviews, Simulations and Test, 4.9 Operational and Live Fire Testing Classroom Exercise 1.3 Materiel Solution Analysis Classroom Exercise 2.4, Test Planning Classroom Exercise 2.2 Source Selection Planning Classroom Exercise 3.3 Source Selection Process
Self Study References	• ACQ 101 Lesson 17, Systems Engineering Process • Defense Acquisition Guidebook, Chapter 4, Systems Engineering

Standardized SE Terminology

Defense Acquisition Guidebook (DAG) para 4.3.1

Disciplined application of SE processes enables

- sound decision making
- increased product knowledge and system maturity
- risk reduction

"All organizations performing SE should scale their application and use of these processes to the type of product or system being developed. This scaling should reflect the system's maturity and complexity, size and scope, life-cycle phase, and other relevant considerations."

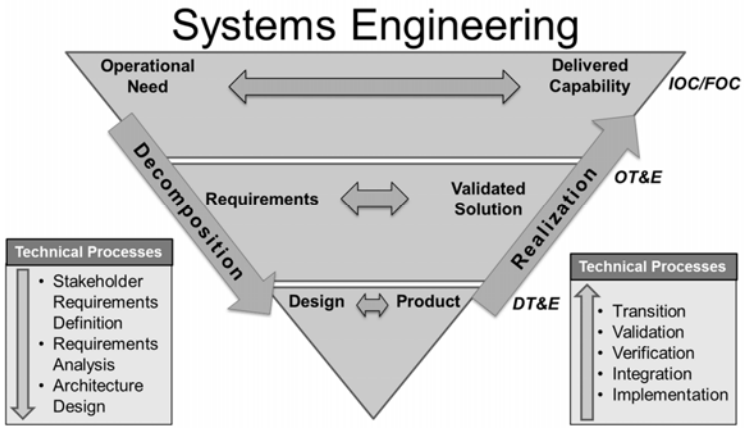
Technical Management Processes

- **Decision Analysis**
- **Technical Planning**
- **Technical Assessment**
- **Requirements Management**
- **Risk Management**
- **Configuration Management**
- **Technical Data Management**
- **Interface Management**

Technical Processes

- **Stakeholder Requirements Definition**
- **Requirements Analysis**
- **Architecture Design**
- **Implementation**
- **Integration**
- **Verification**
- **Validation**
- **Transition**

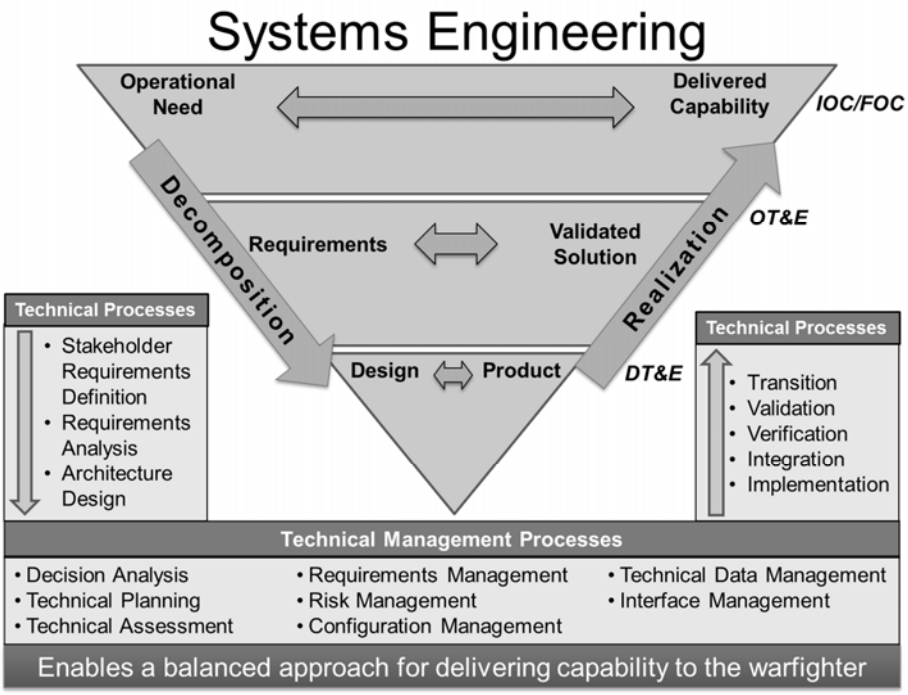
Systems Engineering Process



- **This triangle is a convenient way to illustrate the Systems Engineering Process as described in Chapter 4 of the Defense Acquisition Guidebook (DAG).**
- **SE processes are not meant to be performed in a particular time-dependent or serial sequence. Apply the processes iteratively, recursively and in parallel (as applicable) throughout the life cycle.**
  - The Systems Engineer is responsible for developing the plan and applying the SE processes across the program, monitoring execution throughout the life cycle, and taking necessary steps to improve process efficiency and effectiveness.
  - The Program Manager and Systems Engineer should apply appropriate resources with requisite skill sets to ensure successful execution of each process.

Systems Engineering Processes

The eight **Technical Management Processes** form a "tool kit" used to help manage, control, and provide balance in the execution of the eight **Technical Processes**



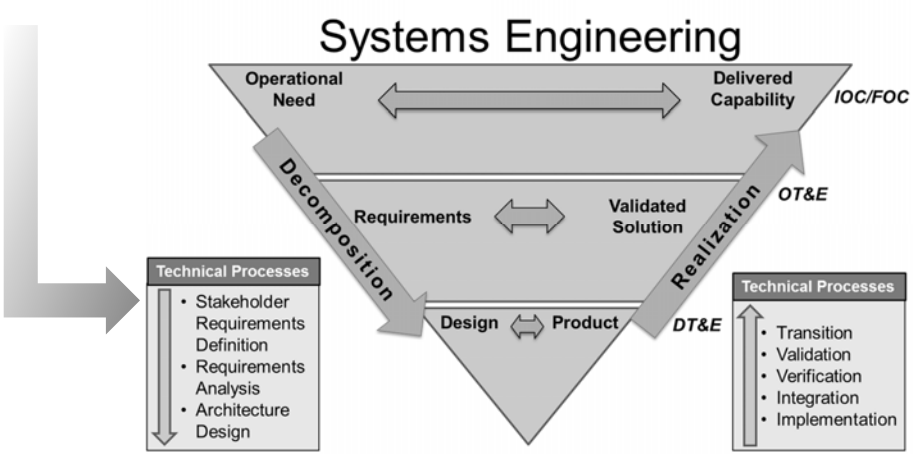
Firebird II Survivability Requirement

Firebird II will incorporate improved survivability measures such that the probability of survivability during a single engagement by a shoulder-launched heat-seeking missile is greater than or equal to 90%.

The warfighter is considering an increase in the survivability requirement to greater than or equal to 92%.

Stakeholder Requirements Definition

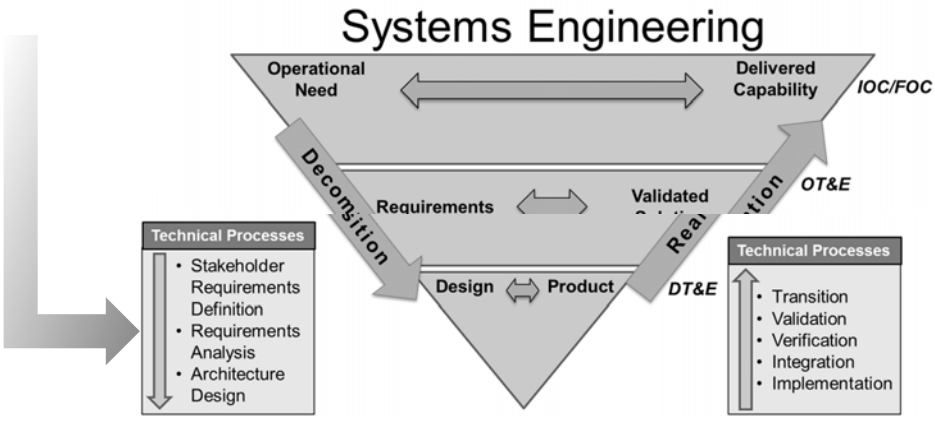
- What is the system supposed to do?
- Where will the products of the system be used?
- Under what conditions will the products be used?
- How often? How long?
- Who will use the products of the system?



Requirements Analysis

This step answers the question: "HOW?" Using "Action Verbs"

- Analyze ***functions***
- Decompose higher level functions to lower level functions
- Allocate performance requirements to the functions

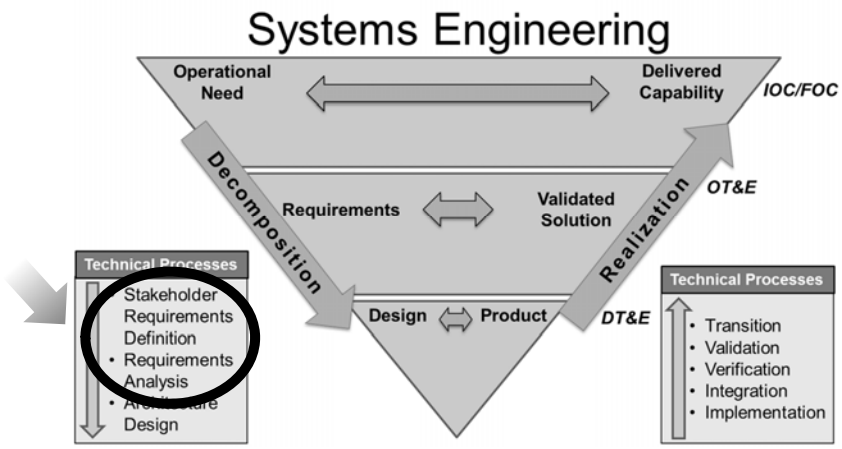


Requirements Traceability

Requirements Management (technical management process) is key to the control and trace-ability of requirements throughout the design, development and fielding of a system.

A feedback loop to ensure that:

- **All requirements are covered by at least one function**
- **All functions are justified by a valid requirement (no unnecessary duplication)**



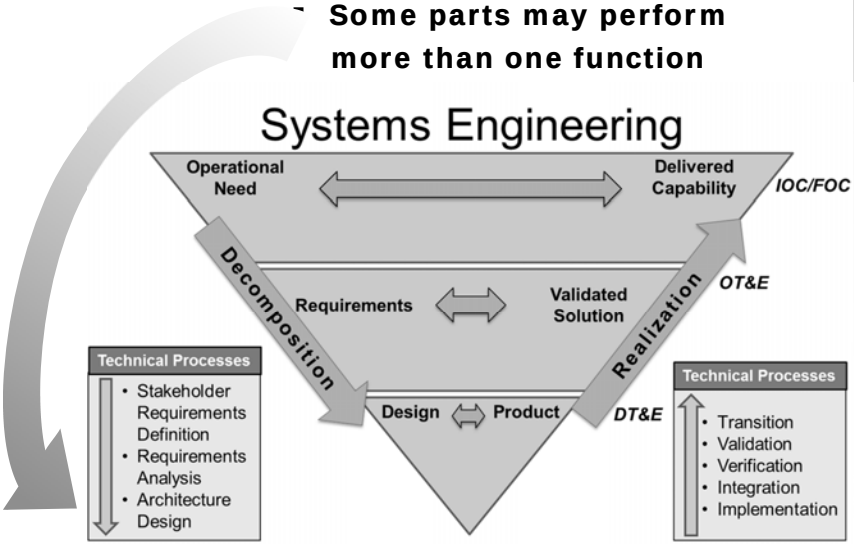
Architecture Design

Defines the physical architecture:

- **Each part must perform at least one function**
- **Some parts may perform more than one function**

What performs the function(s)?

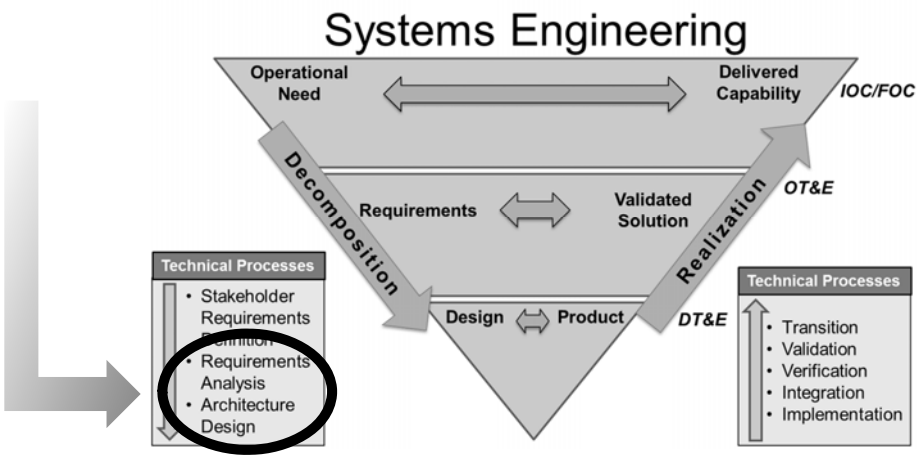
NOUNS are used to describe hardware and/or software elements of the design



Functional / Physical Architecture Crosswalk

A feedback loop to ensure that:

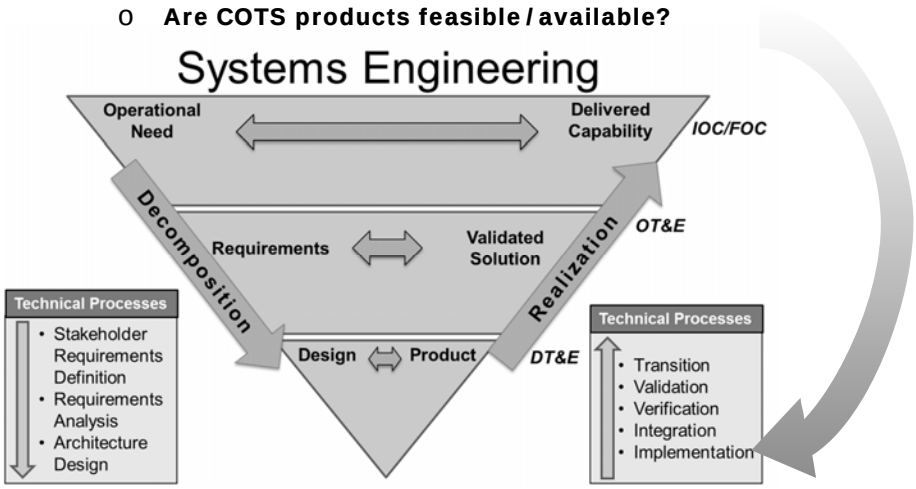
- **All functions are covered by at least one hardware or software element**
- **All elements of the physical architecture are justified by a valid functional requirement (no unnecessary duplication)**



Implementation

- **Determines how the elements of the design will be carried out**
  - **Will software or hardware be used?**
  - **Will it involve a new design (hardware or software)?**
  - **Can components (hardware or software elements) be reused?**
  - **Are COTS products feasible / available?**

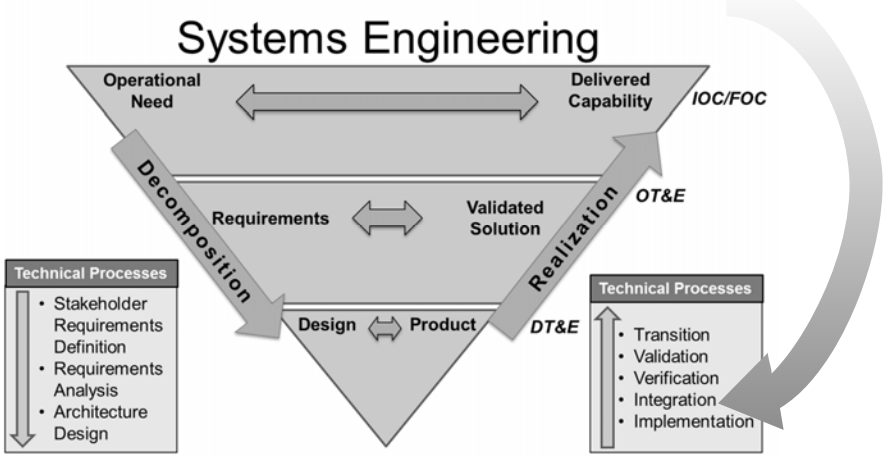
Developing supporting documentation, such as interface requirements, operations and maintenance manuals, and / or installation instructions, is a key part of this SE process step.



Integration

Interface management (one of the SE technical management processes) is especially important to this step of the SE Process.

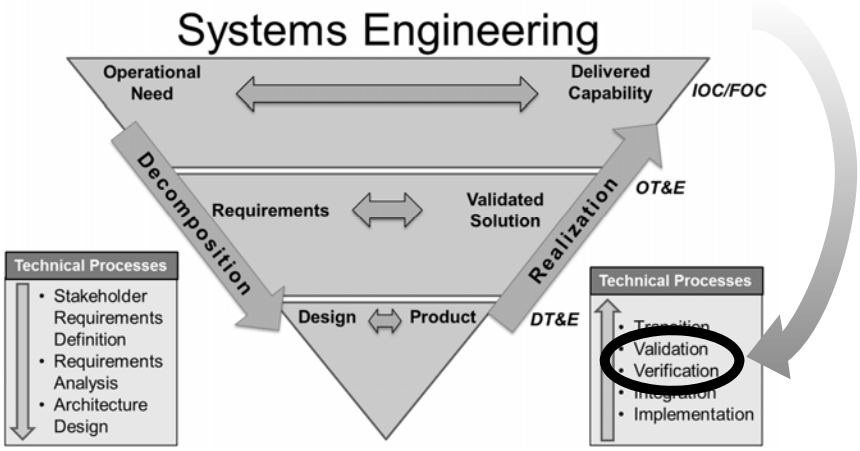
- Incorporates lower level system elements into a higher level system element in the physical architecture
  - Involves linkage of hardware and software elements
  - Analogous to the process of "rolling up" lower level Work Breakdown Structure (WBS) elements into the next higher (subsystem or system) level



Verification and Validation

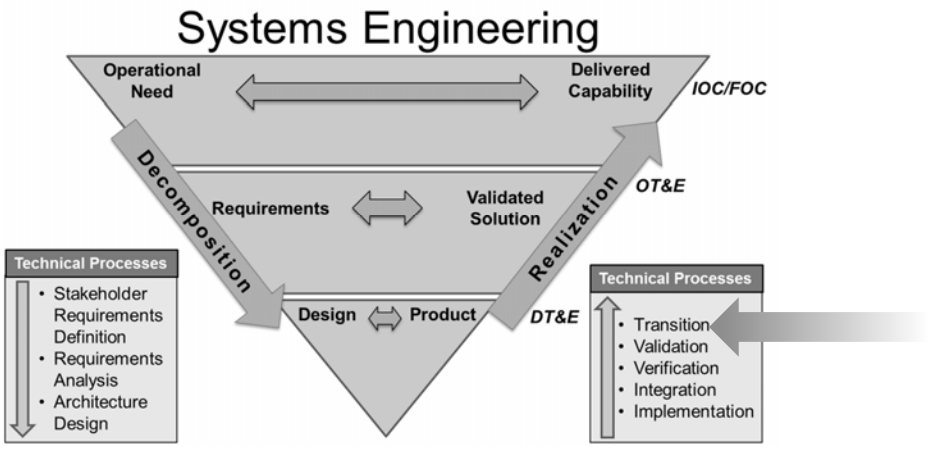
In the triangle Model for Systems Engineering, "Verification" consists of two separate processes, Verification (Developmental Testing, or DT) and Validation (Operational Testing, or OT)

- Each requirement must be verifiable
- The Verification Process ensures that the solution meets the specified (specification) requirements
- The Validation Process ensures that the solution meets the user's needs
- "Verification" can be accomplished by:
  - Inspection - Analysis
  - Demonstration - Test



Transition

- **Process of moving one element in the physical architecture to the next higher level e.g. component to system.**
  - **For the end item (system) this is the process which fields the system to the user in the operational environment**
  - **May require integration of the end item with other systems via the defined external interfaces**

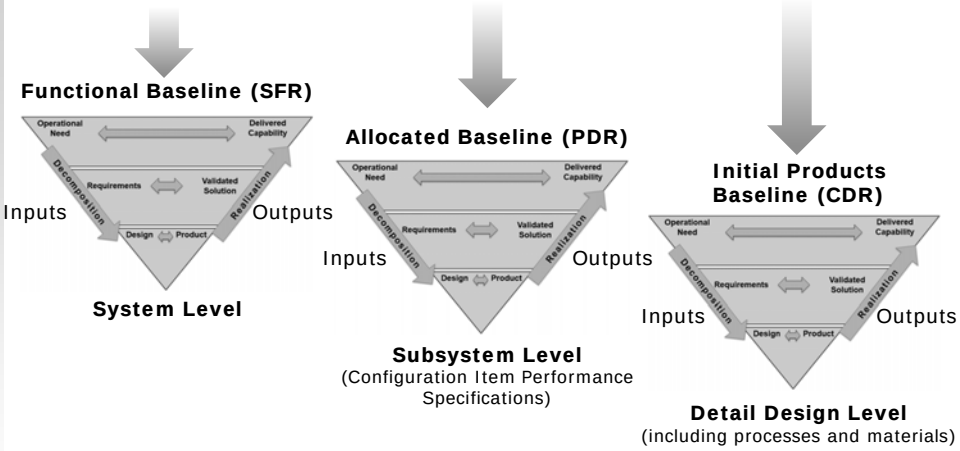


Systems Engineering: An Iterative* and Recursive** Process

***Iterative**: overall SE process is repeated multiple times over the life cycle; technical processes are also repeated as necessary with feedback loops to earlier processes

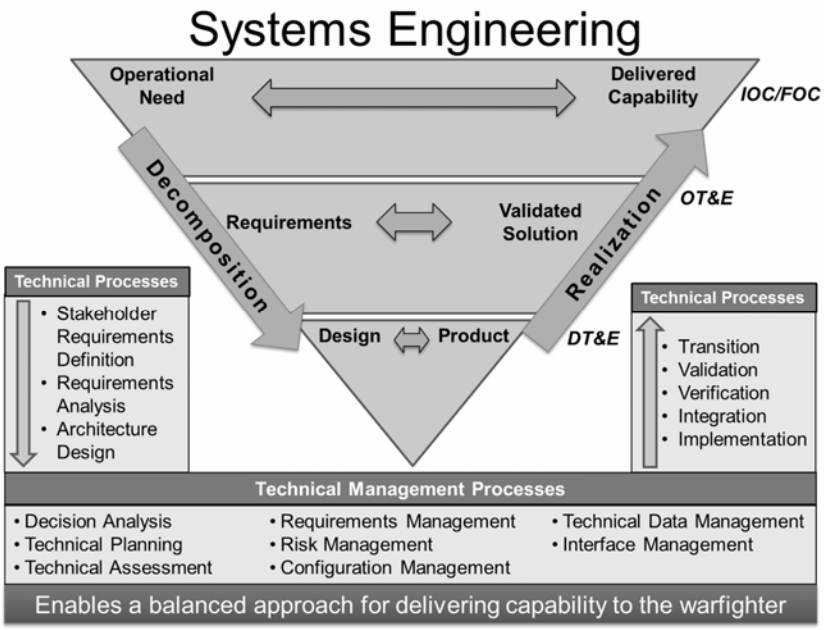
****Recursive**: the SE technical processes are applied at each (successively lower) level of systems development (i.e., system-subsystem-module-component)

3 Successive Iterations of the Configuration Management Baseline



Systems Engineering Process

The objective of the SE process is to develop, produce, test and field a solution that meets user needs.



Exercise 2.3 Systems Engineering

Introduction:

This exercise has been designed to give you "hands on" experience in exercising portions of the systems engineering and technical management process. Before beginning the exercise, there will be a short review of the systems engineering process.

Background:

Flyin-Hyer and CyboRaptor, each with significant UAV experience, proposed different technical solutions. The warfighter has proposed a further increase in the survivability requirement. The Program Manager wants your IPT to evaluate CyboRaptor's technical solution for enhancing survivability to be sure that their physical architecture is affordable, technically feasible, and traceable to the user's increased requirement, which is to be specified in the CDD as follows:

> *Firebird losses due to shoulder-launched missiles are much higher than planned, exceeding the ability of support systems to sustain the system. This has resulted in unacceptably low operational availability and unplanned costs…*
>
> *Firebird II will incorporate improved survivability measures such that the expected loss rate from heat-seeking shoulder-launched missiles is no greater than 8% (threshold)/ (objective).*

CyboRaptor proposes to **upgrade the existing engine to extend the range** of the air vehicle and **increase survivability by adding self-defense enhancements**. The air vehicle will be equipped with a **sensor to detect incoming missiles.** It will **release flares** as decoys to draw heat-seeking missiles away from the vehicle. It will also be equipped with **software upgrades** to give Firebird II **greater maneuvering capability**, further reducing its vulnerability to missile attacks. **In order to meet the warfighter's increased requirement,** CyboRaptor will add a **laser** to **jam** the guidance system of approaching missiles so they cannot engage the air vehicle.

The Program Manager wants you to use the systems engineering process to analyze the requirement for enhanced survivability and evaluate CyboRaptor's technical solution to meet that requirement. First you will perform **Stakeholder Requirements Definition** to determine what the Firebird II system must be able to do, how well, and under what conditions/constraints. You will then use **Requirements Analysis** to determine what functions must be performed and define a functional architecture for the system. Finally, using **Architecture Design,** you will evaluate the technical solution (physical architecture) proposed by CyboRaptor to accomplish the functions identified during Functional Analysis, and verify that it will satisfy the functional architecture and system requirements. A diagram of the systems engineering process is provided on the last page of this exercise for your reference.

Assignment:

The PM has asked your IPT to conduct a trade-off analysis for the increased CDD requirement, using CyboRaptor's proposed technical solution for Firebird II survivability. He wants you to use the Systems Engineering Process as a tool to verify that the proposed technical solution will meet the requirement, and at what cost, in terms of time, money, and risk.

Step 1: Stakeholder Requirements Definition

Your instructor will identify the system requirements derived from the CDD requirement to enhance survivability. Working with your team, **list at least 5 questions** you would need to ask the user to clarify the requirement before you can evaluate the proposed system concept.

Step 2: Requirements Analysis

Based on the requirements identified above, your instructor will identify the system level functions that will need to be performed in order to enhance survivability of the air vehicle. **Analyze each system-level function to break it down one level into sub-functions**. After you complete your analysis of functions, the instructor will discuss with you how to allocate the requirements identified in Step 1 to the functions identified in Step 2.

Step 3: Architecture Design Solution

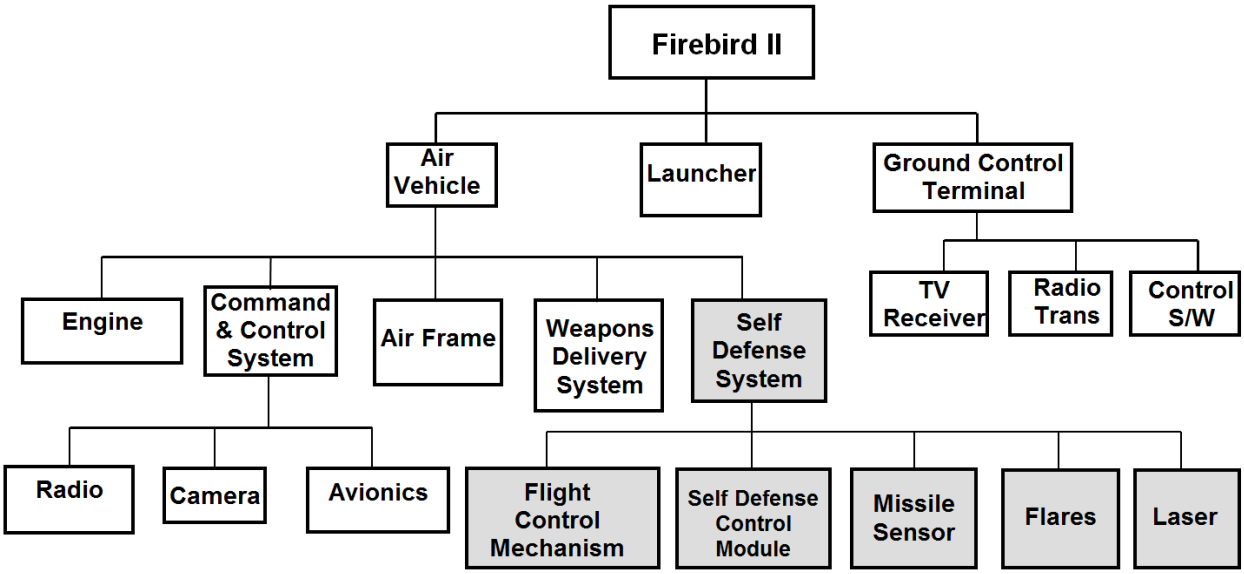
Based on your requirements analysis, compare CyboRaptor's proposed physical architecture for enhancing survivability of the air vehicle (see the next page) to the functional architecture that you developed in the step above. Don't analyze the entire Firebird system; just use the shaded blocks under "Self Defense System."

Your instructor will provide a matrix to guide you in comparing functions to physical components. Are any required functions for the air vehicle not being accomplished by an element in the proposed physical architecture? Are any hardware or software elements in the proposed physical architecture not accomplishing a required function? Based on your comparison, what would you recommend to the warfighter regarding their proposed higher survivability requirement?

CyboRaptor Technical Solution

CyboRaptor's technical solutions for Firebird II is to increase survivability by adding self-defense enhancements. The air vehicle will be equipped with an electronic **sensor** to enable it to detect the threat of approaching missiles. Additional **software upgrades** will provide Firebird II with **greater maneuvering capability**, further reducing its vulnerability to missile attacks and increasing the air vehicle survivability rate. It will also be equipped with **flares,** which will serve as decoys to draw heat-seeking missiles away from the air vehicle. In order to meet the higher survivability, a **laser** is being proposed to jam the guidance system of approaching missiles.

CyboRaptor is also incorporating an **upgraded engine** to give Firebird II the extended range required. The physical architecture for CyboRaptor's technical solution is shown below in Figure 1. This architecture will be further expanded and modified during the Engineering and Manufacturing Development Phase.



CyboRaptor Firebird II Physical Architecture
(Figure 1)

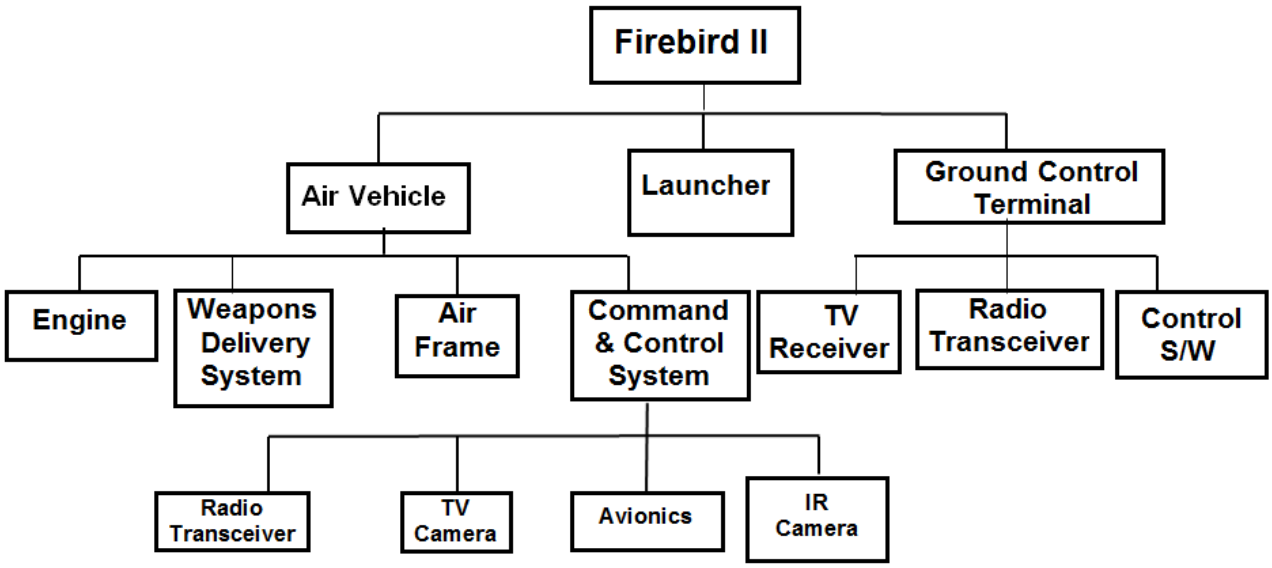
Note: Flyin-Hyer proposes to replace the existing engine with a **new technology engine**. The new engine will both extend the range of the air vehicle and increase its survivability by allowing Firebird to **fly beyond the threat envelope** of shoulder fired munitions.

The Program Manager has reviewed Flyin-Hyer's approach and is confident that their technical soltution, based on using a new engine, has potential to meet both range and survivability requirements. Flyin-Hyer has not yet responded to the government's request for a proposed solution to the warfighter's increased survivability requirement. You do not need to evaluate their technical solution; however it is provided for your information on the following page. You may need to refer to this information in the next exercise on Technical Performance Measures.

Flyin-Hyer Technical Solution

Flyin-Hyer's proposed technical solution is to increase survivability using upgrades to Firebird to allow it to fly outside the threat envelope of shoulder fired munitions (>18,000 ft). A **new technology engine** will enable Firebird II to fly above 18,000 ft. The new engine also provides the UAV with extended range capability. An upgraded **infrared (IR)** camera with high-resolution optics will be added for enhanced night vision capability. Figure 2 below illustrates Flyin-Hyer's physical architecture for their technical solution. This architecture will be further expanded and modified during the Engineering and Manufacturing Development Phase.

NOTE: This technical solution has already been evaluated and approved by the Program Manager.



Flyin-Hyer Firebird II Physical Architecture
(Figure 2)

LESSON ASSIGNMENT SHEET

Lesson Number Exercise 2.4

Lesson Title Test Planning

Lesson Time 1.0 hour

Terminal and Enabling Learning Objective

TLO		**Given a program schedule, explain the role of test and evaluation (DT&E, OT&E, LFT&E) in the systems engineering and acquisition management processes.**
	ELO	Identify the characteristics and purposes of Developmental Test and Evaluation (DT&E)
	ELO	Identify the characteristics and purposes of Operational Test and Evaluation (OT&E)
	ELO	Identify the characteristics and purposes of Live Fire Test and Evaluation (LFT&E)
	ELO	Given a test event description, correctly identify the type of testing being accomplished
	ELO	Given a program schedule, correctly identify opportunities for combined DT/OT
	ELO	Identify the risks and benefits associated with combining DT and OT events

Assignments Review the following ACQ 202 CBT Lesson Summaries:

- Lesson 3.2, Technical Risk Management
- Lesson 2.5, Developing the TEMP
- Lesson 4.5, Reviews, Simulations and Tests
- Lesson 4.9, Operational/Live-Fire Testing

Estimated Student Preparation Time 30 minutes

Assessment Class participation; oral presentation

Related Lessons	CBT Lesson 3.2, Technical Risk Management CBT Lesson 2.5, Developing the TEMP CBT Lessons 4.5, Reviews, Simulations and Tests CBT Lesson 4.9, Operational/Live-Fire Testing Classroom Exercise 1.3 Materiel Solution Analysis Classroom Exercise 3.1 Source Selection Planning Classroom Exercise 3.3 Source Selection Process
Self Study References	N/A

	DT&E	OT&E
What is tested?	Measures technical performance against the design specifications.	Determines operational effectiveness and suitability as defined in the Capability Development Document (CDD) and Capability Production Document (CPD)
Who conducts test?	Government and contractor	Government
Who is responsible?	Program Manager	Independent Operational Testing Agency (OTA)
Where is test conducted?	Controlled Environment	Field Environment

Interoperability certification testing by DISA /JITC is part of DT&E and OA prior to MS C as well as IOT&E after MS C. LFT&E is also accomplished in both OT&E and DT&E.

Developmental Test & Evaluation (DT&E)

- **An integral part of the Systems Engineering process (Verification)**
- **Assesses component and system performance against system specifications**
- **Equipment is usually operated by contractors/engineers in a controlled environment**
- **Overseen by the Deputy Assistant Secretary of Defense for DT&E and the Program Office**
- **Conducted by the contractor and the service developmental test agencies (Army Evaluation Center [AEC], AFMC, Navy Systems Commands, MARCORSYSCOM)**

DT&E Examples

- Environmental Effects Testing
- Captive Engine Tests
- Wind Tunnel Testing
- Component Reliability Testing
- Captive Seeker Tests
- Materials Testing (hardness, corrosion resistance etc.)
- Hardware in the Loop

Operational Test & Evaluation

- In the context of Systems Engineering determines operational effectiveness and suitability (Validation)
- Assesses the system performance against the users requirements as stated in the capability documents
- Equipment is operated by warfighters in an operational environment
- Overseen by the OSD Director, Operational Test & Evaluation (DOT&E)
- Conducted by the service operational test agencies (ATEC-OTC, AFOTEC, COMOPTEVFOR & MCOTEA)

Types of OT&E

Early Operational Assessment (EOA)	**Performed on prototypes to help decision makers assess the proposed concepts.**
Operational Assessment (OA)	Conducted during the EMD Phase to assess the system's potential to meet mission requirements. Supports a Low Rate Initial Production (LRIP) decision.
Initial Operational Test and Evaluation (IOT&E)	Conducted on production or production representative articles to support a Full Rate Production Decision Review.
Follow-on Operational Test and Evaluation (FOT&E)	Conducted after the system is in production and may continue throughout the lifecycle.

Examples of What is Tested in OT&E

- Weapons Accuracy and Lethality
- Communications Effectiveness
- Mission Effectiveness (Many Possible Dimensions)
- System and Weapons Operational Range
- Positioning Accuracy
- Recovery and Repair Procedures
- System Reliability

Live Fire Test & Evaluation (LFT&E)

- **LFT&E assesses 2 major dimensions, Survivability and Lethality**
- **Covered Systems - LFT&E is a statutory requirement for systems that are covered under the law, these include:**
  - Any major system that provides some degree of protection to its occupants in combat.
  - Any major conventional munitions or missile program; or one that will acquire 1,000,000 rounds or more.
  - A modification to a covered system that is likely to affect significantly the survivability or lethality of such a system.
- **A waiver from full up system LFT&E must be approved at Milestone B.**

LFT&E Examples

Early

- **Component testing**
  - Lethality Effects
  - Strength of System Materials Under Fire

Mature System

- **Full Up System Live Fire Testing**
  - Ship Level Shock Test
  - Aircraft Crew Survivability
  - Vehicle Crew Survivability
  - Missile Lethality

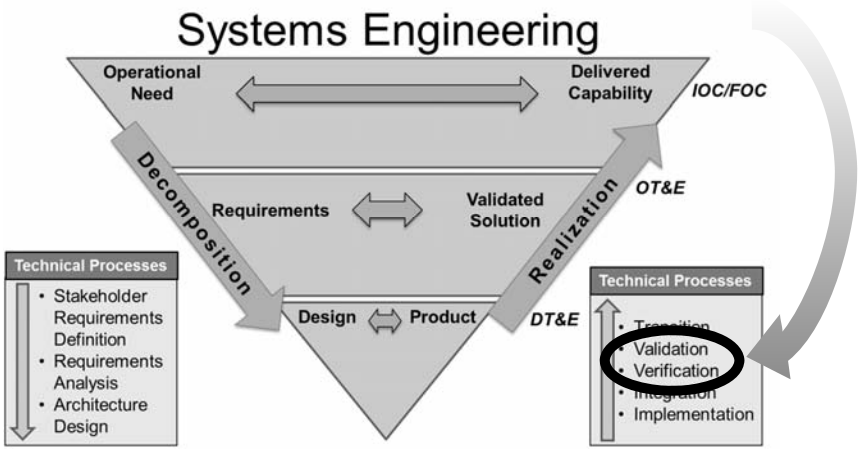
Integrated Testing

- **Integrated DT/OT testing is an expected best practice within the services and DoD**
- **Benefits –**
  - Schedule and cost savings through better use of test resources/data
  - Early identification of operational issues (before IOT&E)
  - Early Warfighter feedback to influence design
- **Risks/Issues –**
  - Independent testers see your system when it is immature
  - Independent OT agency may not want contractors operating equipment
  - DT/OT environments are often not the same

Verification and Validation

In the triangle Model for Systems Engineering, "Verification" consists of two separate processes, Verification (Developmental Testing, or DT) and Validation (Operational Testing, or OT)

- **Each requirement must be verifiable**
- **The Verification Process ensures that the solution meets the specified (specification) requirements**
- **The Validation Process ensures that the solution meets the user's needs**
- **"Verification" can be accomplished by:**
  - Inspection - Analysis
  - Demonstration - Test



Exercise 2.4 Test Planning

Background:

The Firebird II program office is busily putting the final touches on our updated Test and Evaluation Master Plan (TEMP) for the DRFPRD. The Program Manager wants to ensure that we have robust testing of Firebird II to support program decisions in EMD. He also wants to make sure we have integrated developmental and operational testing where it makes sense on the schedule. In this exercise, your team will be asked to help evaluate Firebird II test planning.

For both technical approaches Firebird II will incorporate the same weapons and support equipment that were used in the first increment.

Assignment:

1. For the test events described below come to a team consensus on whether they are DT&E, OT&E, or integrated DT/OT. Be prepared to discuss your answer with the class.

a) The FB II air vehicle will be put through several tests using the wind tunnels at Arnold Engineering Development Center in Tullahoma, TN.

b) Soldiers will conduct several missions over 3 days using an integrated FB II system at White Sands, NM.

c) The FB II will drop a laser-guided bomb on a test range with a hardened infantry emplacement as the target. The target will be instrumented.

d) The FB II operators and maintainers will run through several repair and scheduled maintenance procedures on the integrated system.

e) Thermal imaging of the FB II flare deployment system (Cyboraptor Concept) will be conducted in a laboratory.

f) The FB II engine will be bench tested to obtain reliability and fuel efficiency data.

2. Identify opportunities for integrated test events (DT/OT) during the EMD phase on the FB II schedule. Be prepared to discuss your conclusions with the class:

3. In your opinion, is LFT&E applicable to Firebird II? Why or why not? Who would make the final determination?

LESSON ASSIGNMENT SHEET

Lesson Number Exercise 3.1

Lesson Title Technical Performance Measures

Lesson Time .5 hour

Terminal and Enabling Learning Objectives

TLO		**Analyze actual verses planned technical performance data in risk areas to indicate potential problems that may prevent a system from being operationally effective and suitable.**
	ELO	Identify potential risk areas based on technical performance data
	ELO	Identify the role of technical performance measures in the systems engineering process.

Assignments

Review the following ACQ202 CBT Lesson Summaries:

- Lesson 3.2, Technical Risk Management
- Lesson 2.5, Developing the TEMP
- Lesson 4.5, Reviews, Simulations and Tests
- Lesson 4.9, Operational/Live Fire Testing

Estimated Student Preparation Time 45 minutes

Assessment Class participation; oral presentation

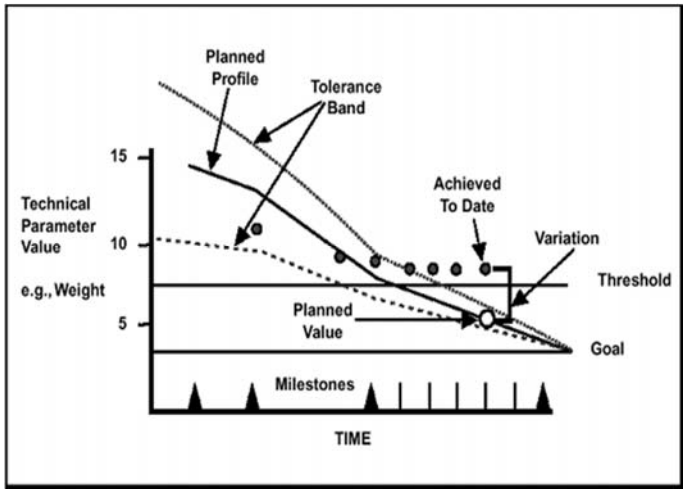
Related Lessons

CBT Lesson 3.2, Technical Risk Management
CBT Lesson 2.5, Developing the TEMP
CBT Lessons 4.5, Reviews, Simulations and Tests
CBT Lesson 4.9, Operational/Live Fire Testing
Classroom Exercise 1.3 Materiel Solution Analysis
Classroom Exercise 2.2 Source Selection Planning
Classroom Exercise 3.3 Source Selection Process

Self Study References N/A

Ex. 3.1 Learning Objective

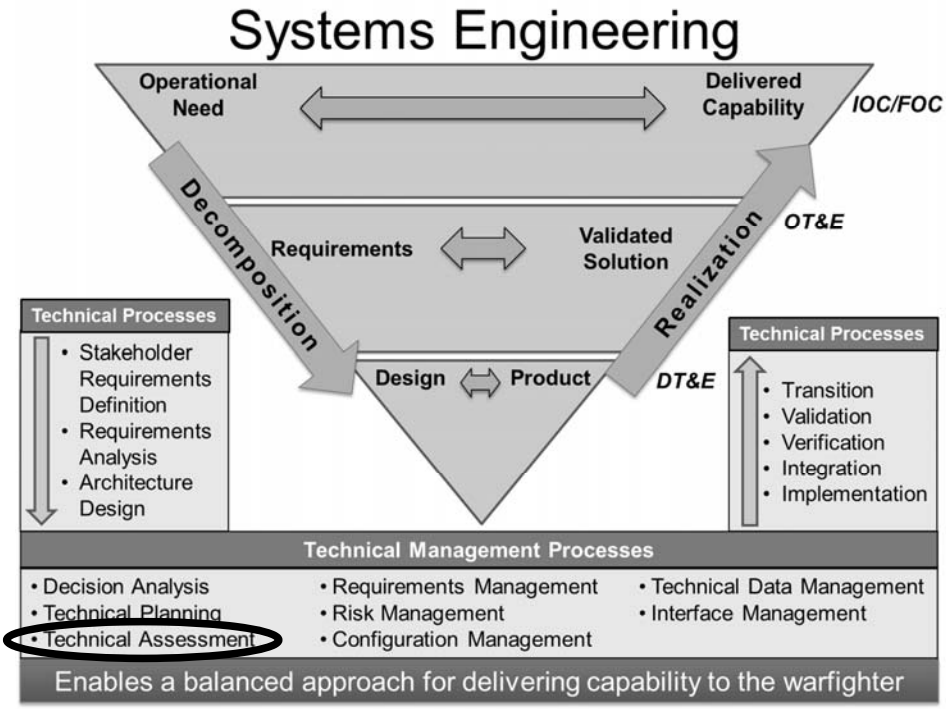
Analyze technical data to identify risks and ensure a system will be operationally effective and suitable.



TPMs are used to track
Progress over Time

TPMs in the Systems Engineering Process

The eight **Technical Management Processes** form a "tool kit" used to help manage, control, and provide balance in the execution of the eight **Technical Processes**



Exercise 3.1 Technical Performance Measures

Background:
CyboRaptor and Flyin-Hyer intend to upgrade or replace the Firebird engine in order to achieve extended range. For the past six months, the contractors have been perfecting their engines and conducting test flights to collect data on range as well as other parameters.

During developmental testing, contractors use critical technical parameters (CTPs), derived from the CDD, to determine whether thresholds and objectives are being met. The Program Management Office can monitor attainment of these CTPs by using technical performance measurement (TPM) data reported by the contractors. Recall that TPMs compare the actual values obtained during test flights against planned or expected values over time.

The raw flight test data received to date from each contractor is summarized at Figure 1.
This data is plotted on TPM charts at Figure 2 for CyboRaptor and at Figure 3 for Flyin-Hyer.

Assignment:
Analyze the test data provided by the two contractors to determine if the technical solution will meet the user's requirements. What can you conclude about the probability of each contractor achieving the required range? What concerns, if any, do you have with each contractor? Be prepared to discuss the risks associated with each contractor's technical solution.

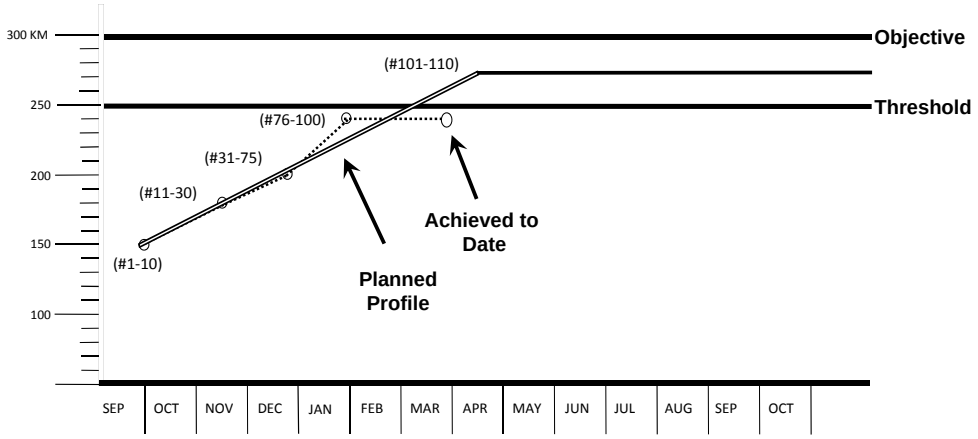
Figure 1

CyboRaptor Test Flight Data		
Test Flight Numbers	**Average Distance Range @ Radius**	**Time of Test Flights**
1 - 10	150 km	SEP
11 - 30	180 km	OCT - NOV
31 - 75	200 km	DEC
76 - 100	240 km	JAN - FEB
101 -110	240 km	MAR - APR

Flyin-Hyer Flight Test Data		
Test Flight Numbers	**Average Distance Range @ Radius**	**Time of Test Flights**
1 - 18	150 km	SEP
19 - 35	200 km	OCT - DEC
36 - 60	300 km	JAN - MAR

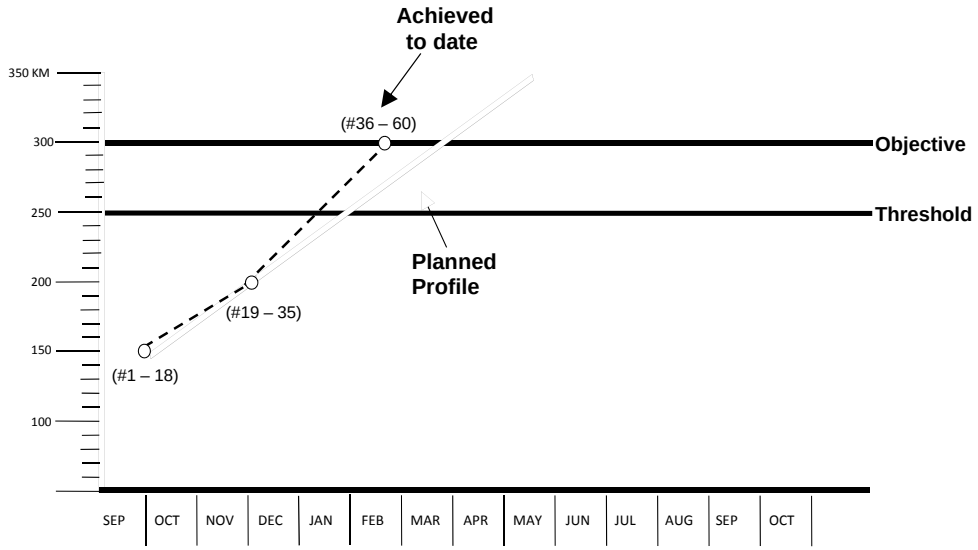
Technical Performance Measurement-Range

CyboRaptor
KPP: Range



Technical Performance Measurement-Range

Flyin – Hyer
KPP: Range



LESSON ASSIGNMENT SHEET

Lesson Number Exercise 3.2

Lesson Title Contractor Planning, Scheduling and Resourcing

Lesson Time 1.5 hours

Terminal and Enabling Learning Objectives

TLO		**Given a segment of contract work and associated tasks, plan and schedule the tasks and resources necessary to complete contract work within cost and schedule constraints.**
	ELO	Apply the fully burdened rate to labor hours to correctly calculate contractor's costs
	ELO	Distinguish correctly between direct and indirect costs on a contract
	ELO	Given a simple Gantt chart with defined task relationships, identify the critical path
	ELO	Given a completed Gantt chart with the critical path identified, identify cost and schedule risks in the plan
	ELO	Given a completed Gantt chart with the critical path identified, explain cost and schedule risks in the plan

Assignments Review the following ACQ202 CBT Lesson Summaries:

- Systems Engineering Exercise 2.3
- Source Selection Process – CBT lesson 3.1
- Technical Risk Management – CBT lesson 3.2
- Earned Value Management – CBT lesson 3.7
- Integrated Baseline Review – CBT lesson 4.7

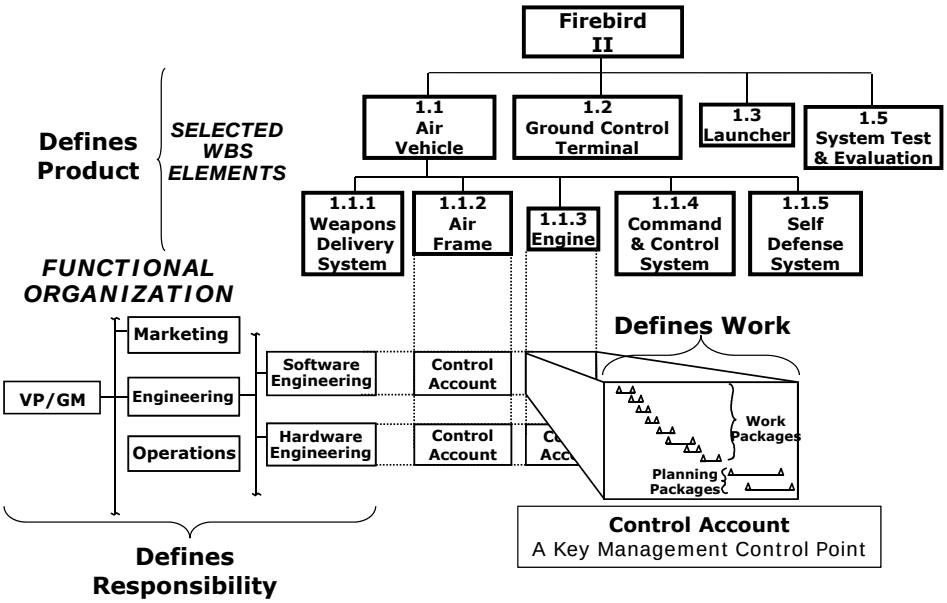
Estimated Student Preparation Time 45 minutes

Assessment Class participation; multiple choice exam

Related Lessons	CBT Lesson 2.3 - Systems Engineering CBT Lesson 3.1 - Source Selection Process CBT Lesson 3.2 - Technical Risk Management CBT Lesson 3.7 - Earned Value CBT Lesson 4.7 – Integrated Baseline Review Classroom Exercise 2.2 Source Selection Planning Classroom Exercise 2.3 Systems Engineering Classroom Exercise 3.1 Technical Performance Measures
Self Study References	N/A

Contract Work Breakdown Structure/ Organization Breakdown Structure Integration

Control Account is the level at which work, schedule, and budget come together



Control Account Manager (CAM)

- **Responsible for allocating resources and planning schedules to accomplish the tasks within a control account (associated with an element of the work breakdown structure)**
- **Work/planning packages the CAM develops within their control account become part of the Integrated Master Schedule (IMS) and the Performance Measurement Baseline (PMB)**

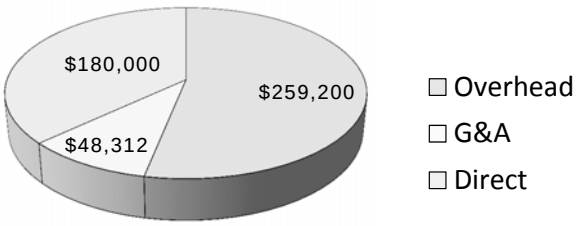
Contractor Costs

- **Direct Costs – A cost that can be tracked directly to one contract or other unit of work (cost objective) for which an accounting system accumulates and measures costs.**
  - Examples: touch labor, purchased parts, computer time

- **Indirect Costs – A cost identified with two or more contracts (cost objectives), but not identifiable directly to a single contract. Indirect costs must be captured in appropriate discrete cost pools. Overhead and General & Administrative (G&A) are commonly used indirect cost pools.**
  - Overhead: Indirect costs that support a specific part or function of the company but not the entire company.
    - Examples: Factory maintenance, material handling
  - General and Administrative: Indirect costs incurred or allocated to a business unit for the general management and administration of the business unit as a whole.
    - Examples: Senior management salary, independent research and development

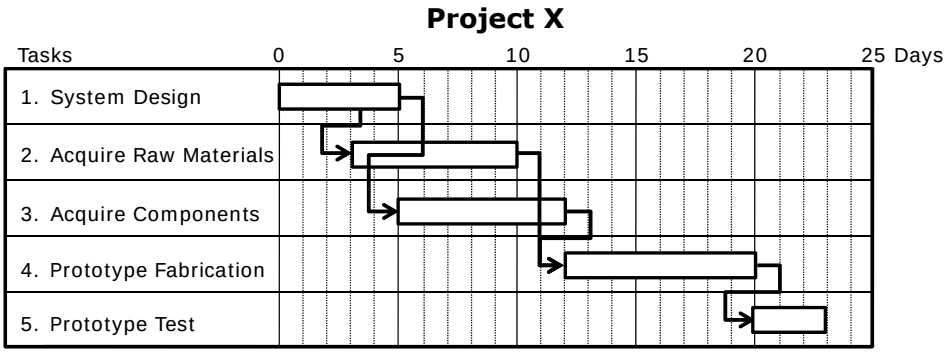
Contractor Costs Example (Fully Burdened Rate)

Category	*Rate*	*Cost*	*Note*
Salary and Benefits		$180,000	Direct Cost
Engineering O/H	1.44	$259,200	Direct Cost X Eng. O/H Rate. Indirect Cost.
G&A	0.11	$48,312	(Direct Cost + Eng. O/H) X G&A Rate. Indirect Cost.
Total Indirect (O/H + G&A)		$307,512	($259,200 + $48,312)
Total Cost (Direct + Indirect)		**$487,512**	**($180,000 + $307,512)**



Critical Path

- **The critical path is the sequence of activities that determine the length of a project**
- **Generally, if any task on the critical path increases in length, the project also increases in length**



Exercise 3.2 Contractor Planning, Scheduling and Resourcing

After consulting his technical staff, Cyboraptor's PM decided to address the range problem by adding a turbocharger to the engine to increase power and fuel efficiency. This will be part of Cyboraptor's proposal in response to the Firebird II final RFP for EMD developmental effort. The Cyboraptor team must now plan out the top level tasks to show that the work can be done with the funds available, within a tight schedule constraint and at an acceptable level of risk.

You are now the contractor team at Cyboraptor that will develop the schedule and budget for this part of the program. Cyboraptor's PM gave you the following top level constraints:

- The work must be completed in 45 work days.
- The budget goal for this work is $270K.
- Schedule is more important than cost because this work is on the critical path of the program and necessary for a major developmental test for which the flight test range has already been scheduled.
- Materials risk is based on the quality of the materials which will most affect performance

Cyboraptor engineers developed the following 11 tasks with associated time and resources.

Task	Sequencing	Time and Labor/material costs
1) Design Turbocharger	Starts immediately	12 Days with 6 engineers, 14 days with 5 engineers, 16 days with 4 engineers or 20 days with 3 engineers
2) Acquire GFE Airflow Mass Sensor	Starts when task #1 is complete	16 days, no cost to contractor
3) Acquire Turbocharger Materials	Starts when task #1 is complete	6 days at a cost of: low risk-$30K, moderate risk-$25K or high risk-$20K
4) Turbocharger Fabrication	Starts when task #3 is complete	8 days with 2 machinists
5) Integrate Turbocharger and Engine	Starts when task #2 and #4 are both complete	4 days with 1 engineer and 2 machinists
6) Test Integrated Turbocharger and engine	Starts when task #5 is complete	6 days with 3 engineers
7) Design, modeling and virtual prototyping of airframe modification	Starts when task #1 is 50% complete	10 days with 2 engineers
8) Purchase Airframe Modification Materials	Starts when task #7 is complete	5 days at a materials cost of $25K
9) Modify prototype airframe	Starts when task #8 is complete	10 days with 4 machinists, 12 days with 3 machinists or 14 days with 2 machinists
10) Wind tunnel test airframe	Starts when task #9 is complete	6 days with 3 Engineers
11) Integrate and test engine and airframe	Starts when tasks #6 & #10 are complete.	4 days with 1 engineer and 2 machinists

Engineers cost $500 per day (Direct Labor) X 2.4 (includes overhead and G&A) = $1200 per day fully burdened rate.

Machinists cost $300 per day (Direct Labor) X 2.2 (includes overhead, benefits etc.) = $660 per day fully burdened rate.

Add a 20% materials overhead (shipping, handling, storage etc.) to all materials costs to get the full cost.

The materials risk for task 3 is in terms of performance.

Assignment:
1) Using the blank Gantt chart provided, develop a schedule for this work package with all 11 tasks sequenced meeting the PM's cost and schedule constraints at an acceptable level of risk.

2) Determine your critical path.

3) What is the biggest risk in this plan and how you would mitigate it?

4) Will Cyboraptor's proposal for the post MS B contract have to change based on this effort?

5) Be prepared to discuss your results with the class.

Firebird II Turbocharger Design and Installation

	0	10	20	30	40	50	Resources: Eng Days	Resources: Mach Days	Resources: Mat $$
1) Design Turbocharger									
2) Acquire GFE Mass Air Flow Sensor									
3) Acquire Turbocharger Materials									
4) Turbocharger Fabrication									
5) Integrate Turbocharger and Engine									
6) Test Integrated Turbocharger and engine									
7) Design, modeling and VP of airframe modification									
8) Purchase Airframe Modification Materials									
9) Modify prototype airframe									
10) Wind tunnel test airframe									
11) Integrate and Test Engine and Airframe									
							Totals		

Hint: Add up engineer days and then multiply by the fully burdened engineer rate.
Add up machinist days then multiply by the fully burdened machinist rate .

LESSON ASSIGNMENT SHEET

Lesson Number Exercise 3.3

Lesson Title Source Selection Process

Lesson Time 1 hour

Terminal and Enabling Learning Objectives

TLO		**Select a best value contractor by comparing contractor proposals and test results to source selection criteria**
	ELO	Apply evaluation criteria in a source selection.
	ELO	Identify the best value approach to source selection
	ELO	Apply a selected tool (e.g. comparison matrix) to resolve a problem

Assignments Review the following ACQ 202 CBT Lesson Summary:

- Lesson 3.1, Source Selection Process

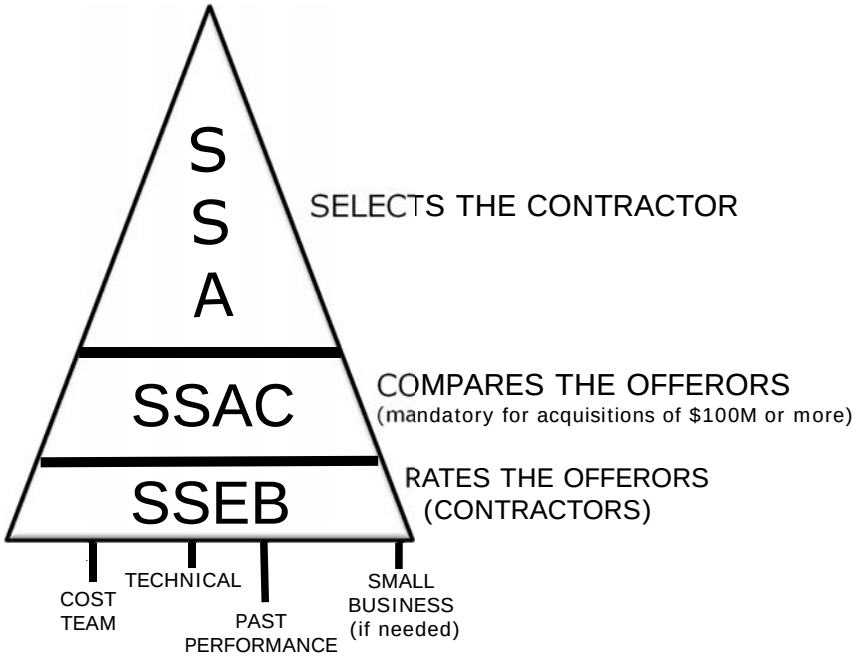
Estimated Student Preparation Time 10 minutes

Assessment Class participation; oral presentation

Related Lessons

- CBT Lesson 2.8, RFP Preparation, Part I
- CBT Lesson 2.9, RFP Preparation, Part II
- CBT Lesson 3.1, Source Selection Process

Self Study References FAR Part 15


S
S
A
SELECTS THE CONTRACTOR
SSAC
COMPARES THE OFFERORS
(mandatory for acquisitions of $100M or more)
SSEB
RATES THE OFFERORS
(CONTRACTORS)
COST
TEAM
TECHNICAL
PAST
PERFORMANCE
SMALL
BUSINESS
(if needed)

1

Exercise 3.3 Source Selection Process

Background:
We are now conducting the down-select of the contractor for the Engineering and Manufacturing Development phase. Flyin-Hyer and CyboRaptor have each submitted a proposal for continued design and development of Firebird II based on the final RFP. The Government technical team has analyzed the contractors' test results and proposals addressing the technical subfactors established in accordance with the source selection plan. The Government technical team evaluation is as follows**:**

Government Technical Evaluation of CyboRaptor Technical Proposal	
Demonstrated Performance	**Risk Findings**
1. **Range**: 240 KM	Design modification plan in place - evaluated as a moderate risk of not reaching the 250 km threshold
2. **Survivability**: 92% against shoulder-launched heat-seeking missiles	Low risk due to success in testing and system adaptability for future improvements
3. **Weapons Accuracy**: 10 meters CEP	Low risk due to mature technology
4. **Launch**: Launched from a stationary mobile launcher unit and safely airborne in 28 feet	Low risk due to mature technology
5. **Mean Time between Critical Failure (MTBCF)**: 160 hours	Low risk due to demonstrated performance
6. **Mean Time to Repair (MTTR)**: 3.1 hours	Improvements in MTTR planned for through low impact design modifications – moderate risk of not reaching 3 hour threshold

Government Technical Evaluation of Flyin-Hyer Technical Proposal	
Demonstrated Performance	**Risk Findings**
1. **Range**: 320 KM	Very low risk due to test performance
2. **Survivability**: 85% against shoulder-launched heat-seeking missiles	Design changes proposed by Flyin-Higher should result in improvement to the 85% survivability achieved in testing, however, the risk of not reaching the threshold of 90% is rated as high
3. **Weapons Accuracy**: 8 meters CEP	Low risk due to demonstrated performance
4. **Launch**: Launched from a stationary mobile launcher unit and safely airborne in 32 feet	Improvements in launch distance planned for – moderate risk of not reaching 30 foot threshold

5. **Mean Time between Critical Failure (MTBCF)**: 140 hours	Improvements in MTBCF expected due to design changes for reliability – moderate risk of not reaching 150 hour threshold
6. **Mean Time to Repair (MTTR)**: 3.3 hours	Improvements in MTTR planned for through design modifications – high risk of not reaching 3 hour threshold

Your IPT is part of the Source Selection Evaluation Board (SSEB). As a part of the SSEB, you will rate one contractor, using the standards you developed and the proposal analysis results provided by the technical team. Your evaluation will be provided to the Source Selection Advisory Council (SSAC) and ultimately to the Source Selection Authority (SSA), who will pick the winning contractor. Once you have completed your work as the SSEB you will switch roles and become the SSAC. As the SSAC you will make a best value recommendation to the SSA.

Assignment:

1. Using the proposal analysis information above, apply the standards you and the other teams developed in Exercise 2.2, Source Selection Planning, as a starting point to rate your assigned contractor in each subfactor. According to the Source Selection Plan, the color rating may be adjusted one color up or down by the SSEB based on the risk information for each factor.

2. Once you reach consensus as a class on the technical performance ratings the instructor will reveal the proposed cost and past performance rating for each offeror. Using the matrix, compare the 2 contractors and come up with a team recommendation of the best value to the government. Be prepared to defend your recommendation to the class.

DRAFT FIREBIRD II CDD PARAMETERS

NOTE: These values come from the CDD which was approved at MS-B. KPPs must be met by the Full Rate Production Decision in response to the Capability Production Document (CPD). KPPs and other performance values in the CPD will be decided by the user prior to MS C.

1. Survivability (KPP):

   Threshold: The UAV must have a probability of survival against shoulder-launched heat-seeking missiles of at least 90%.

2. Range (KPP):

   Threshold: The vehicle must be able to fly out to 250 KM and return to base.
   Objective: The vehicle must be able to fly out to 300 KM and return to base.

3. Weapons Accuracy: (KPP)

   Threshold: 10M Circular Error Probable (CEP)
   Objective: 5 M Circular Error Probable (CEP)

   Note: CEP, the circular error of probability, refers to the radius around the target within which the munitions must fall 50% of the time.

4. Launch:

   Threshold: The UAV must launch from a stationary mobile launcher unit and be safely airborne within a distance of 30 feet.
   Objective: The UAV must launch from a stationary mobile launcher unit and be safely airborne within a distance of 25 feet.

5. Mean Time between Critical Failure (MTBCF) for the UAV must be no less than:

   Threshold: 150 hours
   Objective: 200 hours

6. Mean Time to Repair (MTTR) for the UAV must be no more than:

   Threshold: 3 hours
   Objective: 2.5 hours

Standardized Source Selection Evaluation Ratings

Table 1. Combined Technical/Risk Ratings

Color	Rating	Description
Blue	Outstanding	Proposal indicates an exceptional approach and understanding of the requirements and contains multiple strengths, and risk of unsuccessful performance is low.
Purple	Good	Proposal indicates a thorough approach and understanding of the requirements and contains at least one strength, and risk of unsuccessful performance is low to moderate.
Green	Acceptable	Proposal meets requirements and indicates an adequate approach and understanding of the requirements, and risk of unsuccessful performance is no worse than moderate.
Yellow	Marginal	Proposal has not demonstrated an adequate approach and understanding of the requirements, and/or risk of unsuccessful performance is high.
Red	Unacceptable	Proposal does not meet requirements of the solicitation, and thus, contains one or more deficiencies, and/or risk of unsuccessful performance is unacceptable. Proposal is **unawardable.**

LESSON ASSIGNMENT SHEET

Lesson Number Exercise 3.4

Lesson Title Contractor Performance Measurement

Lesson Time 1.5 hours

Terminal and Enabling Learning Objectives

TLO		**The student will be able to analyze contractor performance indicators to identify trends and problems**
	ELO	Given earned value data calculate cost variance, schedule variance, cost performance index and schedule performance index
	ELO	Given cost variance, schedule variance, SPI & CPI explain the program's cost and schedule status

Assignments Review the following ACQ 202 CBT Lesson Summaries:

- Lesson 3.4 Technical Risk Management
- Lesson 3.7, Earned Value Management
- Lesson 4.6, Contractor Performance Measurement
- Lesson 4.7, Integrated Baseline Review

Estimated Student Preparation Time 45 minutes

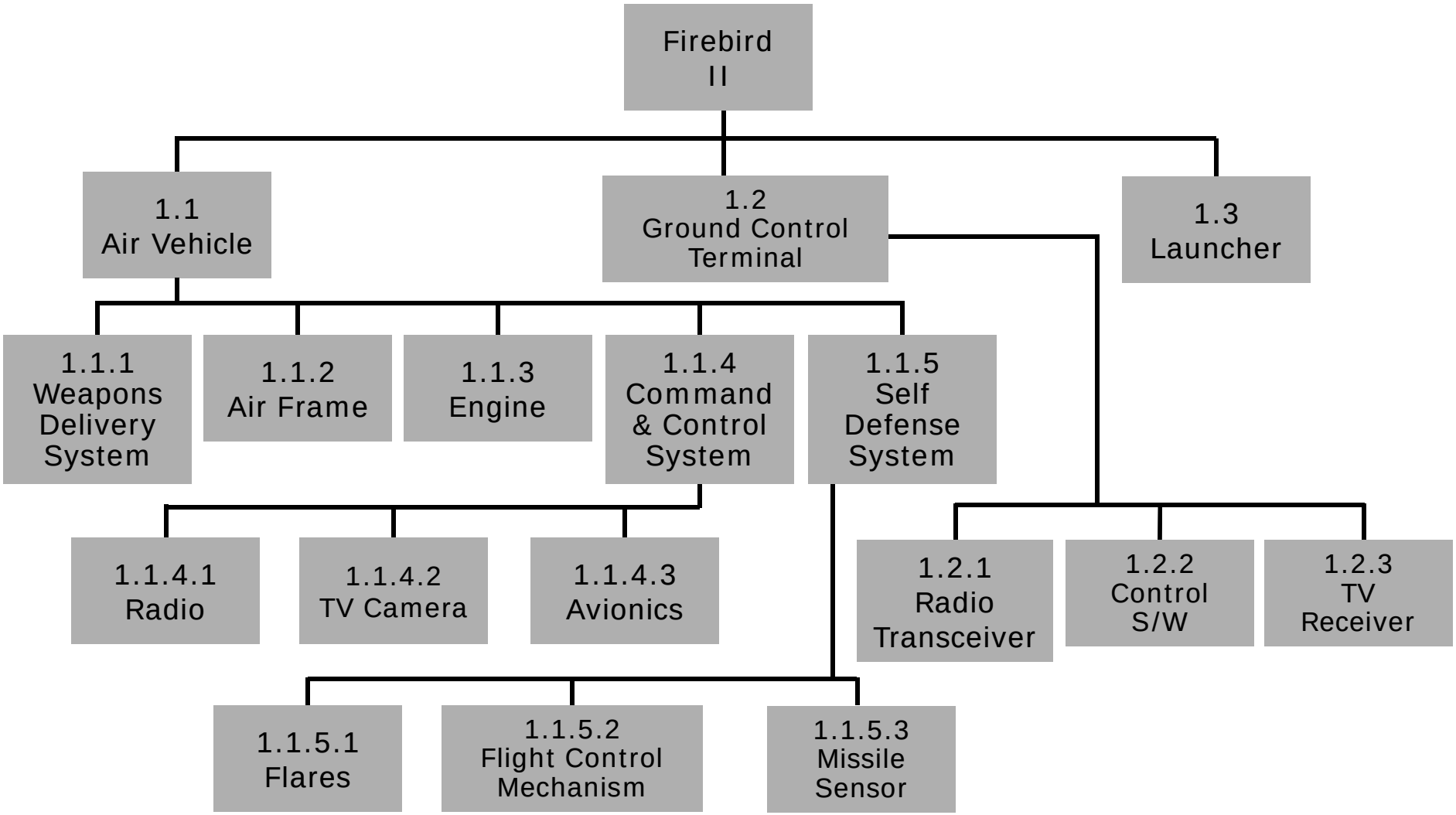
Assessment Class participation; oral presentation

Related Lessons Exercise 2.3, Systems Engineering
Exercise 3.4, Technical Performance Measures
Exercise 3.5, Contractor Planning, Scheduling and Resourcing
Exercise 3.3, Source Selection Process

Self Study References

- DoDD 5000.01, *The Defense Acquisition System*, 12 May 2003
- DoDI 5000.02, *Operation of the Defense Acquisition System,8* December 2008
- *Defense Acquisition Guidebook*

Work Breakdown Structure



INTEGRATED PROGRAM MANAGEMENT REPORT
FORMAT 1 – WORK BREAKDOWN STRUCTURE

DOLLARS IN Millions

FORM APPROVED
Update to OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to be 3.1 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense Washington Headquarters Services Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THIS ADDRESS. SUBMIT COMPLETED FORMS IN ACCORDANCE WITH CONTRACTUAL REQUIREMENTS.**

1. CONTRACTOR	2. CONTRACT	3. PROGRAM	4. REPORT PERIOD
a. NAME: CyboRaptor	a. NAME: FIREBIRD II	a. NAME: FIREBIRD II	a. FROM (YYYYMMDD): YYYY0901
b. LOCATION (Address and ZIP Code): 1100 Carey Ave, Waynesville VA 21345	b. NUMBER: FDS601-20006C-DO23	b. PHASE: EMD	b. TO (YYYYMMDD): YYYY0930
	c. TYPE: FPI (F); d. SHARE RATIO: 60/40	c. EVMS ACCEPTANCE: NO YES YYYY/MM/DD	

5. CONTRACT DATA

a. QUANTITY	b. COST	c. ESTIMATED COST OF AUTHORIZED UNPRICED WORK	d. TARGET PROFIT/ FEE	e. TARGET PRICE	f. ESTIMATED PRICE	h. ESTIMATED CONTRACT CEILING	i. DATE OF OTB/OTS (YYYYMMDD)
N / A	$230.00	0.00	$27.37 / 11.9%	$257.37	$251.67	$283.10	N/A

6. ESTIMATED COST AT COMPLETION

	MANAGEMENT ESTIMATE AT COMPLETION (1)	CONTRACT BUDGET BASE (2)	VARIANCE (3)
a. BEST CASE	$211.60		
b. WORST CASE	$230.00		
c. MOST LIKELY	$221.87	$230.00	$8.129

7. AUTHORIZED CONTRACTOR REPRESENTATIVE

a. NAME (Last, First, Middle Initial)

b. TITLE

c. SIGNATURE

d. DATE SIGNED (YYYYMMDD)

8. PERFORMANCE DATA

ITEM (I)			Current Period					Cumulative to Date					Reprogramming Adjustments			At Completion		
			Budgeted Cost		ACWP	Variance		Budgeted Cost		ACWP	Variance							
			WS	WP		SCH	COST	WS	WP		SCH	COST	CV	SV	Budget	Budgeted	Estimated	Variance
1.1	**Air Vehicle**	2	**14.235**	**12.975**	**14.942**	**-1.260**	**-1.967**	**42.704**	**38.879**	**43.678**	**-3.825**	**-4.799**				**115.881**	**112.468**	**3.413**
1.1.1	**Weapons Delivery**	3	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**				**0.000**	**0.000**	**0.000**
1.1.2	**Air Frame**	3	**0.620**	**0.650**	**0.643**	**0.030**	**0.007**	**1.860**	**1.950**	**1.930**	**0.090**	**0.020**				**6.497**	**6.340**	**0.157**
1.1.3	**Engine**	3	**7.328**	**5.577**	**8.111**	**-1.752**	**-2.534**	**21.985**	**16.730**	**23.184**	**-5.255**	**-6.454**				**58.920**	**57.299**	**1.621**
1.1.4	**C2 System**	3	**1.115**	**1.245**	**1.066**	**0.130**	**0.179**	**3.344**	**3.689**	**3.198**	**0.345**	**0.491**				**8.962**	**8.471**	**0.491**
1.1.4.1	Radio	4	0.700	0.732	0.680	0.032	0.052	2.100	2.150	2.040	0.050	0.110				5.628	5.527	0.101
1.1.4.2	TV Camera	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				0.000	0.000	0.000
1.1.4.3	Avionics	4	0.415	0.513	0.386	0.098	0.127	1.244	1.539	1.158	0.295	0.381				3.334	2.944	0.390
1.1.5	**Self Defense**	**3**	**5.172**	**5.503**	**5.122**	**0.332**	**0.381**	**15.515**	**16.510**	**15.366**	**0.995**	**1.144**				**41.502**	**40.358**	**1.144**
1.1.5.1	Flares	4	1.844	2.009	1.819	0.165	0.190	5.531	6.026	5.456	0.495	0.570				14.823	14.253	0.570
1.1.5.2	Flight Control	4	2.829	2.970	2.808	0.142	0.162	8.486	8.911	8.424	0.425	0.487				22.677	22.185	0.492
1.1.5.3	Sensor	4	0.499	0.524	0.495	0.025	0.029	1.498	1.573	1.486	0.075	0.087				4.002	3.920	0.082
1.2	**Grnd Cont. Terminal**	**2**	**4.002**	**4.087**	**3.942**	**0.086**	**0.146**	**12.005**	**12.262**	**11.825**	**0.257**	**0.437**				**34.025**	**33.010**	**1.015**
1.2.1	Radio	3	1.835	1.836	1.835	0.001	0.001	5.505	5.507	5.504	0.002	0.003				16.605	15.610	0.995
1.2.2	Control Software	3	2.167	2.252	2.107	0.085	0.145	6.500	6.755	6.321	0.255	0.434				17.420	17.400	0.020
1.2.3	TV Camera	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				0.000	0.000	0.000

UPDATE FROM DD FORM 2734/1, MAR 05, PENDING APPROVAL

LOCAL REPRODUCTION AUTHORIZED.

INTEGRATED PROGRAM MANAGEMENT REPORT

DOLLARS IN Millions

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8. PERFORMANCE DATA

ITEM (I)			Current Period					Cumulative to Date					Reprogramming Adjustments			At Completion		
			Budgeted Cost		ACWP	Variance		Budgeted Cost		ACWP	Variance							
			WS	WP		SCH	COST	WS	WP		SCH	COST	CV	SV	Budget	Budgeted	Estimated	Variance
1.3	**Launcher**	**2**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**				**0.000**	**0.000**	**0.000**
1.4	**Sys Prog Mgmt**	**2**	**4.315**	**3.952**	**4.623**	**-0.362**	**-0.671**	**12.944**	**11.857**	**13.303**	**-1.087**	**-1.446**				**51.786**	**52.825**	**-1.039**
1.4.1	Proj Mgmt	3	1.361	1.361	1.423	0.000	-0.063	4.082	4.082	4.270	0.000	-0.188				14.730	14.832	-0.102
1.4.2	Sys Engineering	3	2.954	2.592	3.200	-0.362	-0.608	8.862	7.775	9.033	-1.087	-1.258				37.056	37.993	-0.937
1.5	**Sys T&E**	**2**	**0.884**	**0.802**	**0.844**	**-0.081**	**-0.042**	**2.651**	**2.240**	**2.532**	**-0.411**	**-0.292**				**8.633**	**8.684**	**-0.051**
1.5.1	Dev T &E	3	0.480	0.407	0.443	-0.073	-0.036	1.441	1.222	1.329	-0.219	-0.107				4.897	5.049	-0.152
1.5.2	Oper T&E	3	0.184	0.176	0.184	-0.008	-0.008	0.553	0.528	0.551	-0.025	-0.023				1.440	1.412	0.028
1.5.3	Mockups	3	0.219	0.219	0.217	0.000	0.002	0.657	0.490	0.652	-0.167	-0.162				2.296	2.223	0.073
1.6	**Sys Data**	**2**	**0.294**	**0.280**	**0.293**	**-0.014**	**-0.012**	**0.882**	**0.841**	**0.878**	**-0.041**	**-0.037**				**2.967**	**3.062**	**-0.095**
1.6.1	Eng Data	3	0.136	0.133	0.094	-0.003	0.039	0.407	0.399	0.282	-0.008	0.117				2.025	1.933	0.092
1.6.2	Mgmt Data	3	0.158	0.147	0.199	-0.011	-0.051	0.475	0.442	0.596	-0.033	-0.154				0.942	1.129	-0.187
1.7	**Pec Support Equip**	**2**	**0.557**	**0.526**	**0.624**	**-0.031**	**-0.098**	**1.671**	**1.577**	**1.872**	**-0.094**	**-0.295**				**4.986**	**5.372**	**-0.386**
1.7.1	Test & Measure	3	0.228	0.240	0.323	0.011	-0.083	0.685	0.719	0.969	0.034	-0.250				2.794	3.229	-0.435
1.7.2	Support & Handling	3	0.329	0.286	0.301	-0.043	-0.015	0.986	0.858	0.903	-0.128	-0.045				2.192	2.143	0.049
1.8	**Common Supt Equip**	**2**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**				**0.000**	**0.000**	**0.000**
1.9	**Spares & Rep**	**2**	**0.036**	**0.033**	**0.030**	**-0.003**	**0.003**	**0.107**	**0.099**	**0.091**	**-0.008**	**0.008**				**6.422**	**6.450**	**-0.028**
b. Cost of Money			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				0.000	0.000	0.000
c. GENERAL AND ADMINISTRATIVE			3.203	2.962	3.069	-0.242	0.107	9.610	8.885	9.206	-0.725	-0.321				29.539	29.167	0.372
d. UNDISTRIBUTED BUDGET																0.000	0.000	0.000
e. SUBTOTAL (PMB)			24.321	22.656	25.298	-1.665	-2.642	72.964	67.755	74.179	-5.209	-6.424				224.700	221.871	2.829
f. MANAGEMENT RESERVE																5.300		
g. TOTAL			24.321	22.656	25.298	-1.665	-2.642	72.964	67.755	74.179	-5.209	-6.424				230.000	221.871	8.129
9. RECONCILIATION TO CONTRACT BUDGET BASE																		
a. VARIANCE ADJUSTMENT											0.000	0.000						0.000
b. TOTAL CONTRACT VARIANCE											-5.209	-6.424						8.129

UPDATE FROM DD FORM 2734/1 MAR 05 PENDING APPROVAL

LOCAL REPRODUCTION AUTHORIZED.

Exercise 3.4 Contractor Performance Measurement

This exercise is comprised of two parts. During the first part your team will analyze Integrated Program Management Report (IPMR) data and answer questions regarding the current status of the Firebird II program. You will examine the report for specific work breakdown structure (WBS) elements to determine if the program is on track. During the second part of this exercise, you will review the integrated program status including both IPMR and technical performance measurement (TPM) data to identify program risk and ways to manage that risk.

Background: The Engineering and Manufacturing Development contract awarded to CyboRaptor calls for a 24-month, $230 million effort to complete final development. Under the contract, CyboRaptor will continue developmental testing using design/production representative prototypes and prepare for production of the required modification kits for the UAV.

CyboRaptor will submit monthly IPMRs to report their progress to the Firebird II Program Office.

Assignment 1:

Use the latest IPMR to answer the following questions based on the "Cumulative to Date" and "At Completion" columns only:

1. In general, how is our project doing in terms of cost and schedule?

2. Which element of the WBS is of greatest concern? Why?

3. What level of WBS should the Government pay attention to?

4. What is the Schedule Performance Index (SPI) of the air vehicle? What does that tell us about the contractor's efficiency for this element?

5. What is the Cost Performance Index (CPI) for the air vehicle? What does that tell us about the contractor's efficiency for this element?

6. What is the percent spent for the air vehicle? What does this mean?

7. What is the percent complete for the air vehicle? What does this tell us when compared to percent spent?

8. How will development of the air vehicle turn out if the current trend continues? (Hint: Calculate a Government EAC)

9. Are the variances for the air vehicle consistent with the contractor's projections at complete? What does this indicate?

EXPLANATIONS AND PROBLEM ANALYSIS REPORT

PROJECT: Firebird II – Air Vehicle

CONTRACT: FDS601-20006-D023

DATE: 30 September

SCHEDULE VARIANCE: - 3.825 **COST VARIANCE**: - 4.799

COMPLETION: BAC 115.881 **EAC** 112.468 **VARIANCE** 3.413

PROBLEM ANALYSIS:

COST:
Higher labor costs than planned due to using overtime to investigate anomalies revealed during flight tests. The software conversion/enhancement has been much more complex than early estimate.

SCHEDULE:
Test delayed at Army Test Facility. Recent late receipt of GFE caused a slip in finalizing design of mock-ups. We are currently one month behind schedule.

PROJECTED IMPACT:
Cost and schedule overrun not anticipated.

CORRECTIVE ACTION:
Continue to monitor and aggressively seek solutions to potential problems. Additional data is being gathered on possible link in software interoperability problem.

Assignment 2:

The PM is concerned about the cost overrun and schedule slip in the air vehicle and wants to pin point the problem and take corrective action. Using the IPMR and TPM data provided on the last page, answer the following questions:

1. What does the TPM indicate?

2. Combined with the information provided in the IPMR, what is the greatest area of risk in the project?

3. Given the latest IPMR and the TPM, what is your opinion of the contractor's estimate at completion?

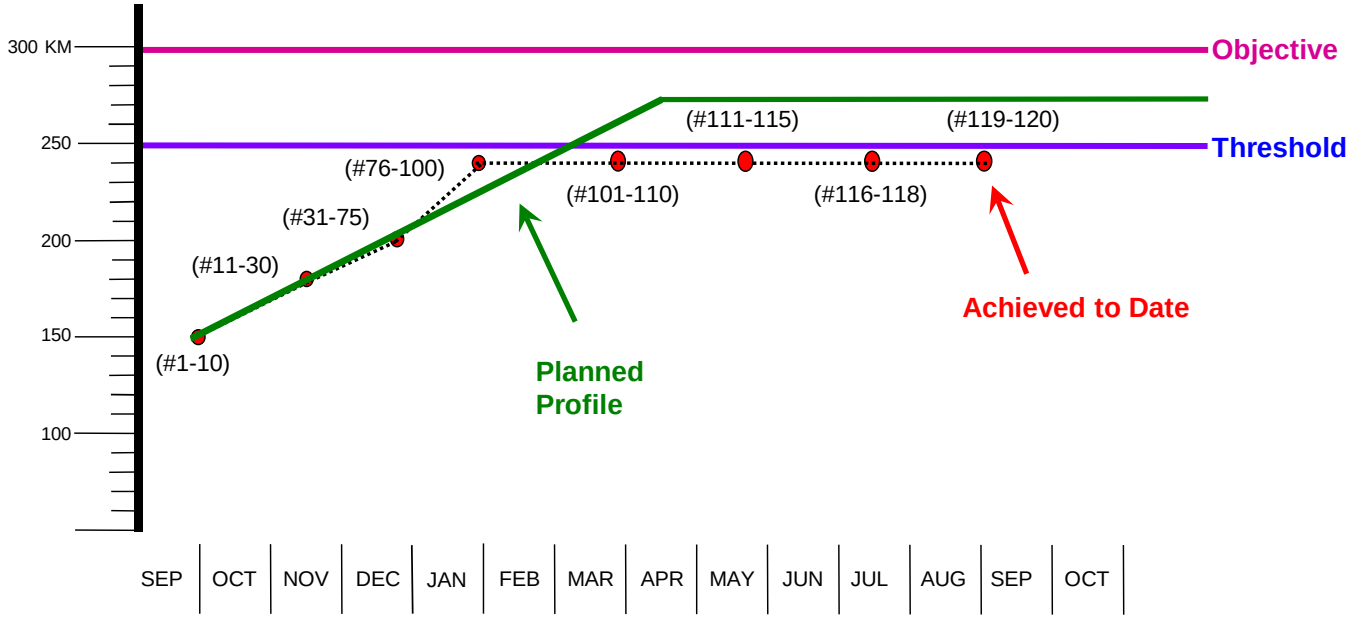
4. What is your confidence in the contractor's ability to complete this project on time and within budget?

5. What are the implications to the overall program (e.g., Acquisition Program Baseline, program master schedule, requirements?) What should we do?

CyboRaptor Test Flight Data		
Test Flight Numbers	Average Distance Range @ Radius	Time of Test Flights
#1 - 10	150 km	SEP
#11 - 30	180 km	OCT - NOV
#31 - 75	200 km	DEC
#76 - 100	240 km	JAN - FEB
#101 - 110	240 km	MAR - APR
#111 - 115	240 km	MAY
#116 - 118	240 km	JUL - AUG
#119 - 120	240 km	SEP

Technical Performance Measurement - Range

CyboRaptor
KPP: Range



LESSON ASSIGNMENT SHEET

Lesson Number Exercise 3.5

Lesson Title Software Interoperability

Lesson Time 2 hours

Terminal and Enabling Learning Objectives

TLO		**Given a scenario, apply key software acquisition management principles needed to make sound decisions for planning and executing an acquisition program.**
	ELO	Recognize the importance of fully integrating cybersecurity into programs early and throughout the system lifecycle.
	ELO	Identify "Best Practices" that may be appropriate for the acquisition of software-intensive systems.
	ELO	Identify the interoperability requirements in the Net Ready KPP as they apply to acquisition of Information Technology
	ELO	Identify the benefits and risks associated with using Commercial Off The Shelf (COTS) software
	ELO	Explain the relationship between software development activities and the systems engineering process.
	ELO	Explain the impact of a new requirement on various functional areas
	ELO	Identify the impacts of a new program requirement on the following functional areas: Program Management, Systems Engineering, Contracting, Lifecycle Logistics, Financial Management, Software Acquisition Management, & Test and Evaluation

Assignments

Read Case 3.5, Software Interoperability Requirement for Firebird, DoD Information Network (DoDIN)

Review the following ACQ202 CBT Lesson Summary:

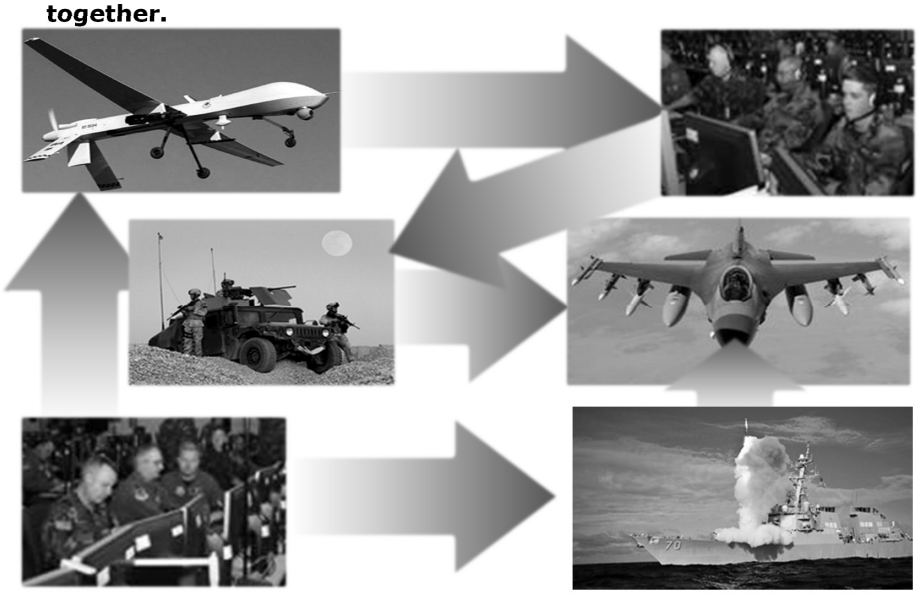
- Lesson 3.4, Software Design
- Lesson 3.5, Commercial and NDI
- Lesson 4.1, Design Changes
- Lesson 4.2, Software Problems

Estimated Student Preparation Time	30 minutes
Assessment	Class participation; oral presentation
Related Lessons	• CBT Lesson 3.4, Software Design • CBT Lesson 3.5, Commercial and NDI • CBT Lesson 4.1, Design Changes • CBT Lesson 4.2, Software Problems
Self Study References	• Software Program Managers Network: http://www.spmn.com • Collection of various lists of DoD "Best Practices": https://bpch.dau.mil/Pages/Default.aspx

Interoperability

(DAU Glossary Definition)

The ability of systems, units, or forces to provide data, information, materiel, and services to and accept the same from other systems, units, or forces and to use the data, information, materiel, and services so exchanged to enable them to operate effectively together.



The 3 NR-KPP Attributes

1) IT must be able to support military operations.

2)IT must be able to be entered and managed on the network.

3)IT must effectively exchange information.

IT = Information Technology

What is Cybersecurity??
(DoDi 8500.01, 12 March 2014)

Prevention of damage to, protection of and restoration of computers, electronic communication systems, electronic communication services, wire communication, and electronic communication, including information contained therein, to ensure its **confidentiality, integrity, availability, authentication,** and **nonrepudiation**.

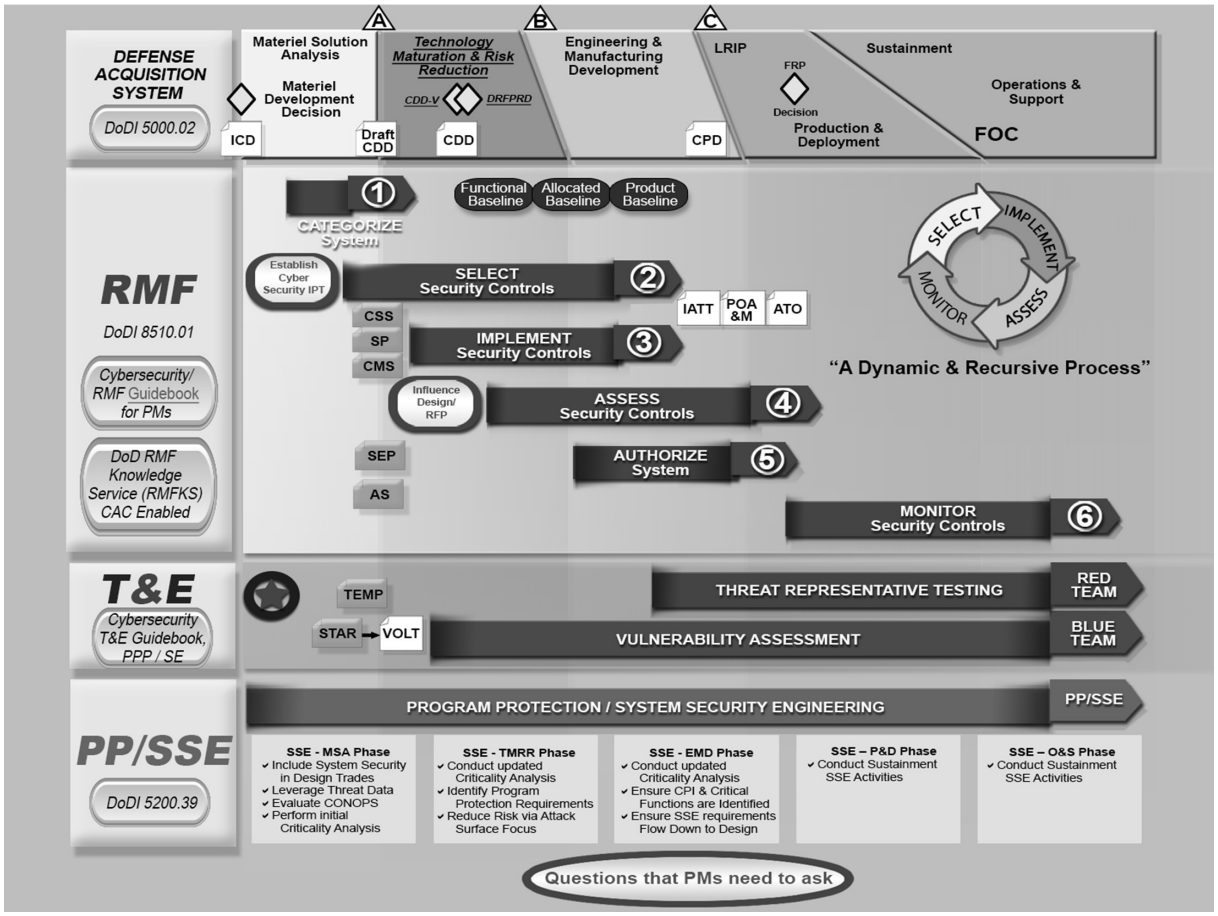
Confidentiality – Is my data safe against disclosure to unauthorized entities?

Integrity - Is my data accurate and consistent over its entire lifecycle?

Availability - Can I access my data/network resources as required?

Authentication - Are data, transactions, communications or documents (electronic or physical) genuine?

Non-Repudiation - Are both parties involved who they claim to be?



Case 3.5, Software Interoperability Requirement for Firebird, Joint Integrated Environment DoD Information Network (DoDIN)

Background:

The Source Selection Authority selected CyboRaptor to continue with Engineering & Manufacturing Development Phase of Firebird II. However, after the CDR a new requirement surfaced…

DoD Information Network (DoDIN)

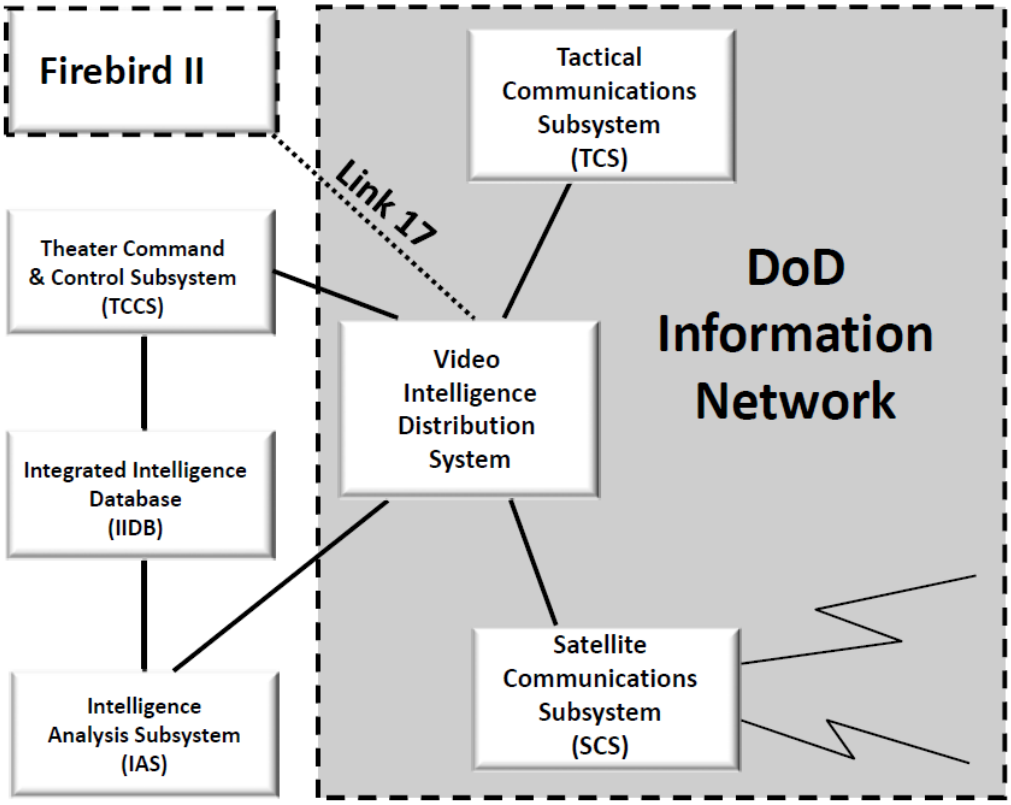
The latest increment of the DoDIN has defined link 17 as the standard for joint sharing of surveillance video.

Link 17 enables the transmission and integration of large amounts of digitized video information from various battlefield and national strategic assets for use in intelligence analysis. Link 17 will enable Firebird video to be entered onto multiple classified networks supporting the DoD intelligence community. Link 17 incorporates three current commercial standards: streaming video, data compression, and public key encryption. The international community as well as the United States has accepted these three standards.

The U. S. Joint Service community has been impressed with the potential of the Firebird air vehicle as a key data sensor source for video. Based on the recommendation of the Configuration Steering Board (CSB), the Joint Requirements Oversight Council (JROC) amended the Capability Development Document (CDD) for Firebird II to require that it transmit compressed video using the Link 17 standard. An Army working group on intelligence, tasked to study potential enhancements to video intelligence distribution, recommended that the JROC designate Firebird II as a special interest program due to the upgrade involving significant software modifications. It may also present some complex integration, interoperability, and reuse issues.

This new requirement was presented at a classified briefing to the Firebird PM and the Milestone Decision Authority (MDA). The Joint Intelligence community also expressed a strong desire to see this new capability demonstrated by Firebird II in the upcoming Joint Warfighter Interoperability Exercise, scheduled 11 months from now. The MDA directed the PM to go back and see what could be done to accomplish this new requirement, on the proposed schedule, and within current program resources.

The diagram outlined below illustrates the connections to the DoDIN of most immediate concern to the members of the Firebird II IPT:



Subset of DoDIN and Interfaces to External Systems

Situation:

The Firebird II IPT considered three options to make Firebird interoperable with Link 17:

(1) Upgrade the current Firebird commercial off-the-shelf (COTS) communications software package,

(2) Replace the current Firebird communications software package with several integrated (COTS) software products, or

(3) Develop new, custom software.

<u>Option 1: Upgrade Current Firebird Communications Software</u>

Steve Larson, the Firebird Systems Engineer, met with Poore Associates, the vendor of COMVID (version 5.1), the current Firebird COTS video communications package. Mr. Poore told Steve that the next release of COMVID (version 5.3) would have Link 17 capability. Sam Robins, the Firebird PMO's software engineer, obtained a beta copy of COMVID 5.3 for purposes of government suitability assessment. Sam knew that a preliminary technical evaluation was a best practice when considering new COTS releases. Sam used DoDIN test data with the new COMVID software. Sam determined that the COTS software would meet the basic requirements for Firebird II; however, he found numerous anomalies and reported the problems to Steve and to Poore Associates.

When Steve next met with Poore Associates the conversation was cordial. Mr. Poore said that Sam's reported problems would be given due consideration. However, based on the lack of a specific plan to correct the problems, Steve was skeptical that Poore could fix all the anomalies by the announced commercial release date (eight months from now). Poore also mentioned the licensing cost to the Firebird program for the new software release would be $600,000.

Option 2: Replace with Alternative COTS Software

Sam discovered, through some calls to associates, that the R&D center in Huntsville, AL was running Link 17 experiments through other COTS packages. Sam obtained the test data from the software life cycle support center (an element of the Huntsville R&D center). Sam found that the center could emulate the full functionality of Link 17 by using several COTS products with additional integration software (affectionately nicknamed "glue code"). Sam was advised that the licensing costs to Firebird for the COTS packages alone would cost approximately $1,000,000. This does not include the price of the glue code from the R&D center or any follow-on support.

Sam ran the same tests as with the beta COMVID software and had success, with the exception of slow response by Firebird to the DoDIN. When Sam showed these test results to Steve, Steve noted that the measured response times from Firebird did not meet the real-time performance constraints for the DoDIN. Despite the fact that the alternative COTS suite had all the required functionality, Steve reluctantly ruled out this option because of the poor response time results.

Option 3: Develop New Custom Software

Steve asked Sam to research the possibility of using an available Federal Supply Schedule (FSS) Information Technology (IT) Indefinite Delivery, Indefinite Quantity (IDIQ) contract to custom develop the software for Firebird II Link 17 capability. Sam found two software companies under an IDIQ contract that could do the work and requested offers for delivery of a software product that would meet Firebird II's requirements.

- Roman & Associates responded to the software development requirement with an offer of $1,500,000 and 10 months to deliver the specified software product to Firebird.
- Dynasoft responded to the same requirement with an offer of $1,750,000 and 8 months to deliver the specified software product to Firebird.

Sam noted that Roman & Associates was rated Level 3 on the Software Engineering Institute (SEI) Capability Maturity Model Integration (CMMI), and Dynasoft was rated at Level 4. Both companies emphasized that their offers entitled the Government to government purpose data rights. Also, neither offer addressed the cost or availability of follow-on maintenance.

Assignment:

1. Your instructor will assign each team one of the options to evaluate. Consider the question below that pertains to your assigned option:

   - Option 1 - Software Upgrade. What are the issues associated with relying on Poore's new COMVID release?

   - Option 2 - Alternative COTS. Was Steve premature in ruling out the alternate COTS software option? Why or why not?

   - Option 3 - New Development. What are the issues with developing new custom software to meet Firebird II's interoperability requirements?

2. Identify the pros and cons associated with your assigned option.

3. For your assigned option, what would be the risks if the PM decided to go this way? In determining risk factors, you should consider the functional areas listed below.
   (Note: any risks addressed should be program specific, not general risks such as cost, schedule, and performance.)

Acquisition Logistics	Test and Evaluation
Systems Engineering	Software Development
Contracts Management	Funds Management

4. Recommend a mitigation strategy for at least one of your identified risks.

5. Recommend a cybersecurity strategy for enabling the following for your assigned option.

   Option 1 – confidentiality of information (FB II video)

   Option 2 – integrity of FB II's video data in the DoDIN

   Option 3 – availability of FB II video to support military operations

6. Would you recommend this option?

LESSON ASSIGNMENT SHEET

Lesson Number Exercise 4.1

Lesson Title Reliability

Lesson Time 2 hours

Terminal and Enabling Learning Objectives

TLO		**Analyze a reliability problem from multiple perspectives and select and defend a solution**
	ELO	Explain the interrelationship between selected functional areas (e.g., contracting, finance, systems engineering) and acquisition logistics.
	ELO	Explain why it is important to influence system design for supportability.
	ELO	Explain the relationship of Reliability, Availability, and Maintainability (RAM) to Acquisition Logistics, and its impact on system performance, operational effectiveness (including support), logistics planning, and life-cycle cost.
	ELO	Identify and the impacts of a supportability problem on the following functional areas: Program Management, Systems Engineering, Contracting, Lifecycle Logistics, Financial Management, Quality Assurance & Manufacturing, & Test and Evaluation
	ELO	Explain how instability of requirements, design, and production processes impact program cost and schedule.

Assignments Review the following ACQ 202 CBT Lesson Summaries:

- Lesson 1.2, Selecting the Best Approach
- Lesson 2.3, Developing the Life Cycle Sustainment Plan
- Lesson 3.3, Design for Supportability/Trade-Off Analysis

Estimated Student Preparation Time 10 minutes

Assessment Class participation; oral presentation

Related Lessons

- CBT Lesson 1.2, Selecting the Best Approach
- CBT Lesson 3.3, Trade-Off Analysis
- CBT Lesson 3.6, Role of Manufacturing

Self Study References

N/A

DoDI 5000.02

12. RELIABILITY AND MAINTAINABILITY (R&M)

"a. The Program Manager will formulate a comprehensive R&M program using an appropriate strategy to ensure reliability and maintainability requirements are achieved…..

b. For MDAPs, the Program Manager will prepare a preliminary Reliability, Availability, Maintainability and Cost Rationale (RAM-C) Report in support of the Milestone A decision. This report provides a quantitative basis for reliability requirements, and improves cost estimates and program planning. This report will be attached to the SEP at Milestone A, and updated in support of the Development RFP Release Decision Point, Milestone B, and Milestone C.

c. Reliability growth curves (RGCs) will reflect the reliability growth strategy and be employed to plan, illustrate, and report reliability growth. RGCs will be included in the SEP at Milestone A and updated in the draft SEP submitted at the Development RFP Release Decision Point and in the final approved SEP and Test and Evaluation Master Plan submitted at Milestone B…"

Lesson 4.1 - Reliability Issue

Background:

The Full Rate Production Decision Review (FRPDR) for Firebird II is only two months away, when a potentially serious problem develops with the countermeasures control module in the air vehicle.

Tom, from Test & Evaluation, receives conflicting data from CyboRaptor on whether the control module they plan to use will meet the Mean Time Between Critical Failure (MTBCF) minimum requirement of 300 hours for this component. Limited developmental testing of the module indicates that 300 operating hours MTBCF is attainable. However, computer-based parametric models predict an MTBCF of only 200 hours. **This presents a potential reliability issue.**

Tom consults with Larry from Logistics in the next cubicle, who convinces Tom to bring their dilemma to Steve, the Systems Engineer. After some discussion with Steve, they decide the best solution is to conduct three months of additional testing to better determine the module's reliability. However, when they take this recommendation to the PM, COL Cole, he says **there may not be enough time or money for additional testing.** Instead, COL Cole directs them to talk with the contractor and user reps and then prepare a discussion paper with various options for handling this risk and the tradeoffs involved.

Tom contacts the user reps, who state categorically that they are "tired of getting burned by poor reliability" and are unwilling to reduce the MTBCF requirement. They also make it clear that they don't want any schedule slips.

Steve calls Zeke, his counterpart at CyboRaptor. Zeke says the best solution from his perspective is to go with a better module. It will cost more, but it will provide increased reliability. Zeke agrees to fax details to Steve; then, before hanging up, adds that whatever the Government decides, they must do it quickly to avoid costly delays. **"Indecision on this issue will quickly put us behind schedule**" says Zeke. Steve, Tom and Larry meet again and prepare the following discussion paper for the PM:

Discussion Paper

From: Engineering Design Team

To: Colonel Cole

Subj: Control Module Options

Computer-based modeling conducted by CyboRaptor revealed a potential reliability issue with the UAV countermeasures control module. While limited environmental testing indicates the module will operate for 300 hours, parametric models predict a problem that will reduce Mean Time Between Critical Failure (MTBCF) to as low as 200 hours, 33% below the requirement.

CyboRaptor could apply special coatings and heat sinks to the module during production, but they say this additional process would be inefficient. Instead, CyboRaptor recommends the use of a more reliable, and more expensive, solid state module. The user reps are adamantly opposed to reducing the MTBCF requirement, since all their supportability analyses, planning and resultant funding profiles for support costs depend on the module operating properly for 300 hours. They are tired of battling numerous reliability problems with current systems and don't want Firebird modifications to add any more problems.

Below is a summary of the options we came up with after discussions with CyboRaptor and military user reps:

Option 1 – Stay with the current module.

If the module proves reliable, this option has the advantage of maintaining the current cost and schedule baseline. We estimate the probability of meeting the required 300 hour MTBCF is 80%, based on the conflicting results of the limited testing and the parametric models. However, if this option is chosen and the reliability falls short, major operational and maintenance problems will result, including system performance degradation due to poor reliability, availability and maintainability. In the current design, replacement of modules later on would require extensive dismantling and reassembly of the air vehicle. No funds have been programmed to allow for additional maintenance costs, and currently there is no time or money for additional testing.

Option 2 – Modify the existing module.

This will require production changes to ensure the modules meet the 300 hour MTBCF. Some new manufacturing equipment and changes to the planned manufacturing process will be needed in preparation for the upcoming Full Rate Production Decision Review. The resultant schedule slip is expected to be 60 days. In addition, this option will increase production costs by $3,750 per air vehicle for the 400 retrofit kits. No funds have been budgeted to pay for these changes.

Option 3 – Replace the module.

This is easier than altering the manufacturing process, but the new module will cost an additional $7,500 per vehicle for the 400 retrofit kits. There is no money for a more expensive module. In addition, our market research indicates the three available vendors cannot meet our initial quantity requirements due to temporary shortages from high demand, but they promise that this will not happen once the current shortage is overcome. We estimate this will result in a production delay of at least 90 days. However, this commercially available module is guaranteed to work for over 500 hours before failure.

Signed,
Steve, Larry and Tom

Col. Cole reads the discussion paper and thinks to himself, "What should I do now? I guess this is why I get the big bucks..."

Assignment:

1. Pick a group leader/briefer. Each team member should take on the role of a different functional area expert or stakeholder (e.g., user, logistician, systems engineer, funds manager, tester, production and quality manager).
2. Discuss in your team the pros and cons of each option. Then reach consensus on the best approach to recommend to the PM, based on the information provided and any assumptions you feel are necessary.
3. For your recommended approach, examine the impact in terms of the user, logistician, systems engineer, funds manager, tester, and PQM manager.
4. Prepare a 5-10 minute brief explaining your recommended choice, assumptions, and supporting rationale.

LESSON ASSIGNMENT SHEET

Lesson Number Exercise 4.2

Lesson Title Contract Change

Lesson Time 1 hour

Terminal and Enabling Learning Objectives

TLO		**Recognize an unauthorized commitment situation and avoid giving inappropriate direction to a contractor.**
	ELO	Explain the interrelationship between selected functional areas (e.g., life cycle logistics, finance, systems engineering) and contracting.
	ELO	Identify the causes and consequences of unauthorized commitments
	ELO	Identify the complementary roles and responsibilities of the contracting officer and the program manager in their partnership throughout the acquisition process.
TLO		**Given a scenario, apply the procedures, rules and public laws associated with the execution of DoD budgets.**
	ELO	Identify the public laws (i.e., Misappropriation Act, Anti-deficiency Act, Bona Fide Need Rule) that apply to the use of appropriated funds in DoD acquisition.
	ELO	Select the appropriate public law (i.e., Misappropriation Act, Anti-deficiency Act, Bona Fide Need Rule) that applies to the use of appropriated funds under specific circumstances.

Assignments Review the following AC202 CBT Lesson Summaries:

- Lesson 4.4, Reprogramming Funds
- Lesson 5.2, Unauthorized Commitments
- Lesson 5.4, Change Orders

Estimated Student Preparation Time 15 minutes

Assessment Class participation; oral presentation

Related Lessons	• CBT Lesson 4.4, Reprogramming Funds • CBT Lesson 5.2, Constructive Changes • CBT Lesson 5.4, Change Orders
Self Study References	N/A

Lesson 4.2 - Contract Change

Part 1: Contractual Direction and Authority

Background:

After receiving the discussion paper, Col. Cole considered his options. He knew money was extremely tight, and that a lot was riding on his ability to get Firebird II to the fighting forces on time and within budget. He decided to have CyboRaptor stay with the original control module and accept the 20% risk that it would not meet the MTBCF requirement in spite of the model's conflicting predictions.

A New Problem:

Three weeks after the start of full rate production (FRP), Connie, Firebird's Procuring Contracting Officer, receives an unexpected package in the morning's mail. The cover letter begins: "CyboRaptor is pleased to submit the enclosed Request for Equitable Adjustment for the changes described herein." Slightly stunned, and growing angrier by the minute, Connie's eyes drift to the bottom of the page and she sees the words, "…increase in production contract price by $3,000,000 and extends the delivery schedule by 90 days." "Get the PM on the horn right away," she calls to her secretary as she mutters to herself, "Why am I always the last to know?"

The Story:

Connie has supported the Firebird program since its inception. After discussions about the technical complexities, programmatic uncertainties, and fiscal risk of the Firebird II upgrade, she and the PM agreed that the best contract type for full rate production lot options would be firm fixed price (FFP). Both felt that this type of contract would adequately distribute risks of the program between the parties based on the maturity of the technologies and the availability of adequate cost data.

CyboRaptor, the prime contractor for both the original Firebird and Firebird II, is well known in the industry for quality products. The company's management recently promoted Howard Hagan to the position of program manager for Firebird II, due to his extensive familiarity with UAV technology. While Howard had worked periodically on various stages of Firebird's original development, this is his first assignment as a program manager, and he is determined to please his customer and make this project successful for both himself and his company.

U.S. Pacific Command (PACOM) has a high level of interest in the development and eventual fielding of Firebird II. Consequently, PACOM recently selected and permanently stationed an O-5 in the PMO to represent the interests of their Operational Commands and to serve as liaison officer (LNO) with the "developers." CDR Flyboy has no acquisition experience but was chosen because of his extensive experience with operational units currently employing Firebird.

Upon reporting as the LNO, Flyboy learned of the risk of reliability problems in the UAV control modules, and he decided to take action. Feeling strongly about his professional responsibilities to the sailors, soldiers, airmen and marines in operational units, he telephoned RADM Adams, his

boss at PACOM. After a brief discussion of the problem, Flyboy asked the Admiral's permission to have CyboRaptor make the system more reliable for its ultimate warfighting customers by using the higher quality, more expensive module. RADM Adams replied that he didn't understand the issue well enough to comment, but he would rely on Flyboy's knowledge of the program and his warfighting expertise to proceed as he thought best for all concerned.

Flyboy convinced COL Cole to let him visit CyboRaptor's production facility and take a tour of their plant. Cole called Howard, who said he would be glad to have Flyboy visit. Cole then explained to Flyboy that his visit was simply intended to provide him with fundamental information about, and orientation with, the current status of the program. He went on to explain that the FRP contract options were firm fixed price, meaning that Government control of contractor operations was minimal, due to the relatively certain nature of the technical requirements and associated work.

Before touring the production facility, Flyboy was taken to Howard Hagan's office for a courtesy call. Over coffee, Flyboy expressed his concern about the reliability of the control module. He said he felt strongly that using a better module would maximize the effectiveness and survivability of the system. Flyboy also said he hoped Hagan would do whatever was necessary to make sure Firebird II performs with the required reliability. Hagan nodded frequently appearing interested and sympathetic to Flyboy's concerns.

After the meeting with Hagan, Flyboy took a tour of the plant with one of the production supervisors. It was a worthwhile visit, with Flyboy asking lots of questions and gaining valuable insight into the Firebird program.

The next day, eager to please his customer, Hagan put his staff to work developing and implementing a solution consistent with Flyboy's direction. Hagan instructed his staff to proceed with any actions necessary to satisfy this revised requirement for better reliability. Sensing the urgency in Hagan's voice, they immediately placed orders for the more expensive module to minimize impact on the delivery schedule. Hagan assumed that COL Cole would be pleased with his initiative and resultant action taken to avoid a future problem.

Assignment:

Consider and develop answers to the following questions. Be prepared to explain your answers to the class.

1. What is the authority and responsibility of:
   - CDR Flyboy?
   - COL Cole?
   - RADM Adams?
   - Connie?

2. What role should the Administrative Contracting Officer (ACO) have played in this scenario?

3. Is the Government liable for Flyboy's actions?

4. Should Howard Hagan have relied on Flyboy's direction?

5. If you were COL Cole, what actions would you take?

6. Who messed up?

Part 2 - Funding Issue

PM decides to use the new module after all

COL Cole, after a lot of soul-searching and some additional indications that the current module would not meet MTBCF requirements, decides that the right thing to do is use the more expensive module and pay the claim from CyboRaptor. He sweet-talks the users into giving him an additional 90 days of schedule. The Government contracting official (the Head of the Contracting Activity) agrees to ratify the change once the PM certifies that appropriate funds are available and Connie, with legal counsel concurrence, recommends payment. But where will the money come from???? He puts in a call to Faye, his trusted funds manager.....

Intern to the Rescue

Faye is away on TDY, but her energetic new intern comes up with what he believes is a solution to the money dilemma. He says that the Mustang program down the hall in the same PEO has enough RDT&E money to pay for the cost of the request for equitable adjustment from CyboRaptor and is willing to fork it over since they can't use before it expires.

Assignment

Discuss and develop an answer to the following question in your group and be prepared to explain your answer to the class.

Did the intern come up with a good funding solution? Why or why not?

Statement of Limitation of Authority

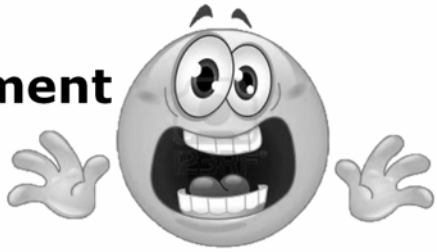
You are hereby notified that I DO NOT have the authority to direct you in any way to alter your contractual obligation. Further, if the Government, as a result of the information obtained from today's discussion DOES desire to alter your requirements, changes will be issued in writing and signed by the contracting officer. You should take no action on any change unless and until you receive such a contract modification.

Types of Contract Modifications

- **Supplemental Agreement**

- **Change Order**

- **Unauthorized Commitment**



Supplemental Agreement

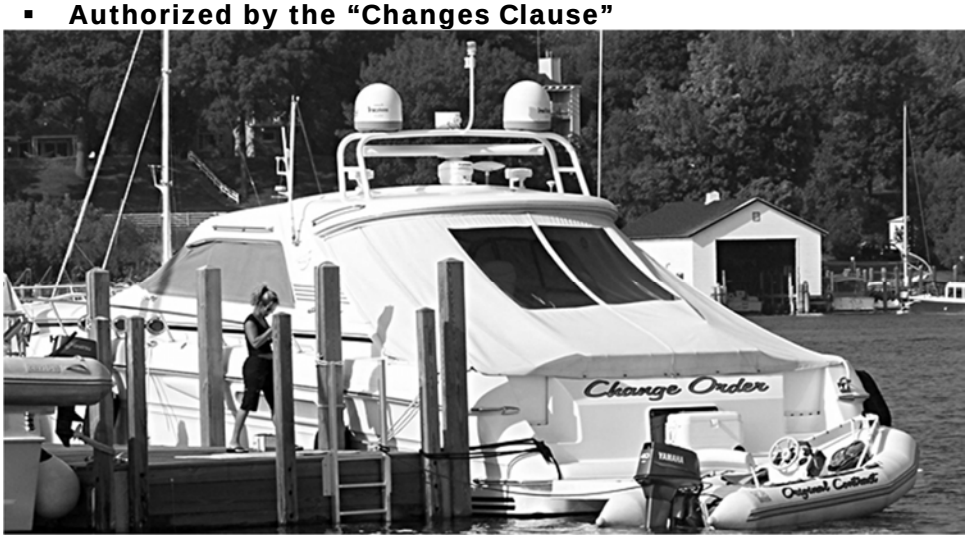
- **Contract mod based on prior agreement of parties regarding the change**
- **Incorporates equitable adjustment to contract cost and/or schedule as a result of the change**

Change Order

- **Written order issued by CO directing contractor to make a change without prior agreement**
- **Creates "undefinitized" Government liability**
- **Contractor may be entitled to equitable adjustment**
- **Authorized by the "Changes Clause"**

Change Order must be within the scope of the contract – limited to

- Drawings, designs, or specifications
- Method of shipping or packing
- Increase or decrease in Govt Furnished Property
- Place of delivery
- FAR 52.243-1&2



Unauthorized Commitment

- **An Unauthorized Commitment is an agreement that is not binding solely because the government representative who made it *lacked the authority* to enter into that agreement on behalf of the government.**

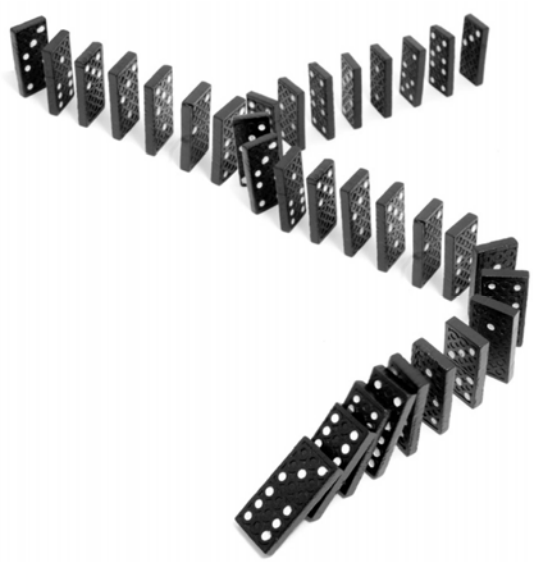
- **Must involve:**
  - Change in performance beyond minimum contract requirements, and
  - Word or deed by Government representative which requires contractor effort that is not a necessary part of the contract

- **Requires Ratification by Head of Contracting Activity**

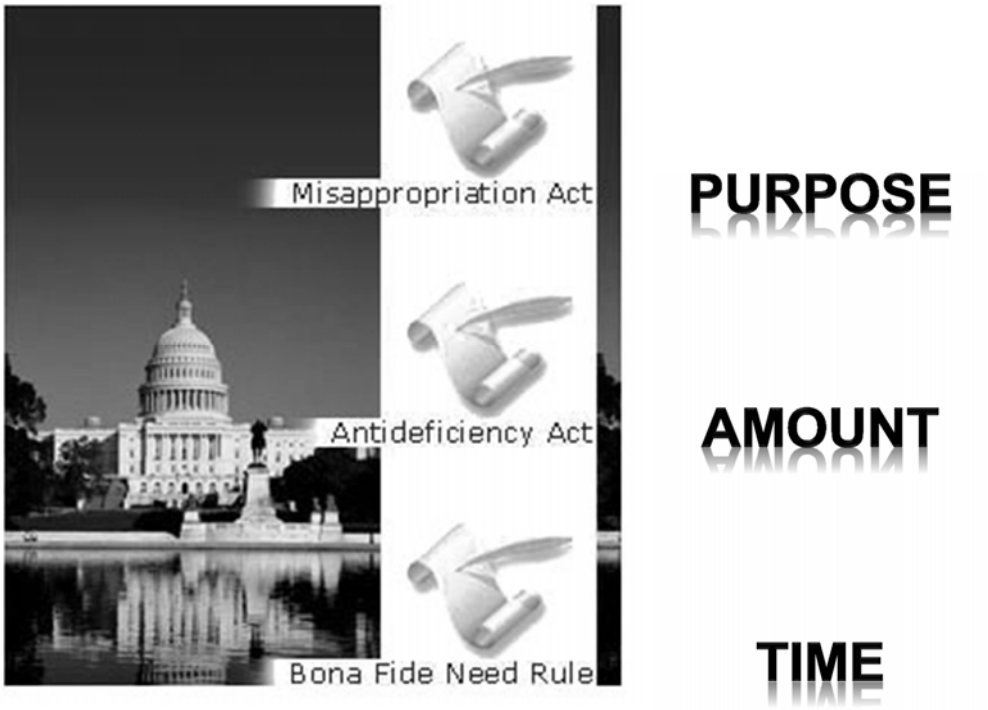
Contract Change Effects

All functional areas will be affected by a contract change, not just the contracting officer. What are some possible repercussions in these areas?

- Program Management
- Financial Management
- Logistics
- Test and Evaluation
- Systems Engineering



Use of Appropriated Funds



Appropriated Funds

- **<u>Misappropriation Act</u> (Purpose)**
  - Requires funds to be used only for the purposes and programs for which the appropriation was made.
- **<u>Anti-Deficiency Act</u> (Amount)**
  - Prohibits making or authorizing an obligation in excess of the amount available.
- **<u>Bona Fide Need Rule</u> (Time)**
  - Requires funds to be used only for needs in the year of the appropriations obligation

LESSON ASSIGNMENT SHEET

Lesson Number Exercise 4.3

Lesson Title Problem Solving Excerpt

Lesson Time 1.0 hours

Terminal and Enabling Learning Objectives

TLO		**Analyze the elements of manufacturing as they relate to a systems performance problem using a qualitative tool (cause and effect/fishbone diagram)**
	ELO	Identify the elements of manufacturing (5Ms).
	ELO	Explain the considerations/concerns of the elements of manufacturing (5Ms) and how other areas are affected.
	ELO	Explain the impact of manufacturing on cost, schedule and performance.
	ELO	Explain the use of the 5 Whys root cause determination method in identifying potential root causes.
	ELO	Explain the multi-voting technique to narrow large lists of possibilities into smaller, more manageable, lists.

Assignments Review the following ACQ 202 CBT Lesson Summaries:

- Lesson 3.6, Role of Manufacturing
- Lesson 5.1, Best Manufacturing Practices

Estimated Student Preparation Time 30 minutes

Assessment Class participation; oral presentation

Related Lessons Exercise 2.3 Systems Engineering

Self Study References N/A

Exercise 4.3, Problem Solving

Background:

Firebird II is now one year into full rate production. One hundred retrofitted air vehicles have been fielded to Army, Navy, and Air Force units around the world. The UAV has been used successfully in a number of joint military training exercises without incident. However one day, after returning from a routine training mission, a post-flight inspection of a Firebird II air vehicle revealed that the **flare container was missing**. An incident report was immediately filed with the proper authorities, as required. It wasn't long, however, before the flare container was recovered, as it had fallen from the air vehicle and landed on the Base Commander's lawn! The entire Firebird fleet was grounded and an investigation into the cause of the incident began.

Preliminary Investigation Results:

The preliminary incident report indicated the flare container attachment bracket had **stress cracks around the bolt attachment points.** Several of the bolts were missing. The **bolt holes appeared to be slightly elongated**. (Note: The brackets, which are recessed into the airframe, are attached to the fuselage at the factory, but the flare containers are installed at the organizational/squadron level for each flight evolution. The containers are reusable and refilled with flares after the flares are expended during mission flights.)

The flare container fell off within 1 mile of the landing area. It appears to have detached at a relatively low altitude during its descent and landing. The flare containers are government furnished equipment (GFE) from existing inventories. Though the containers are from a new production lot, the flare container design has been in use for the past 25 years.

Weather conditions:

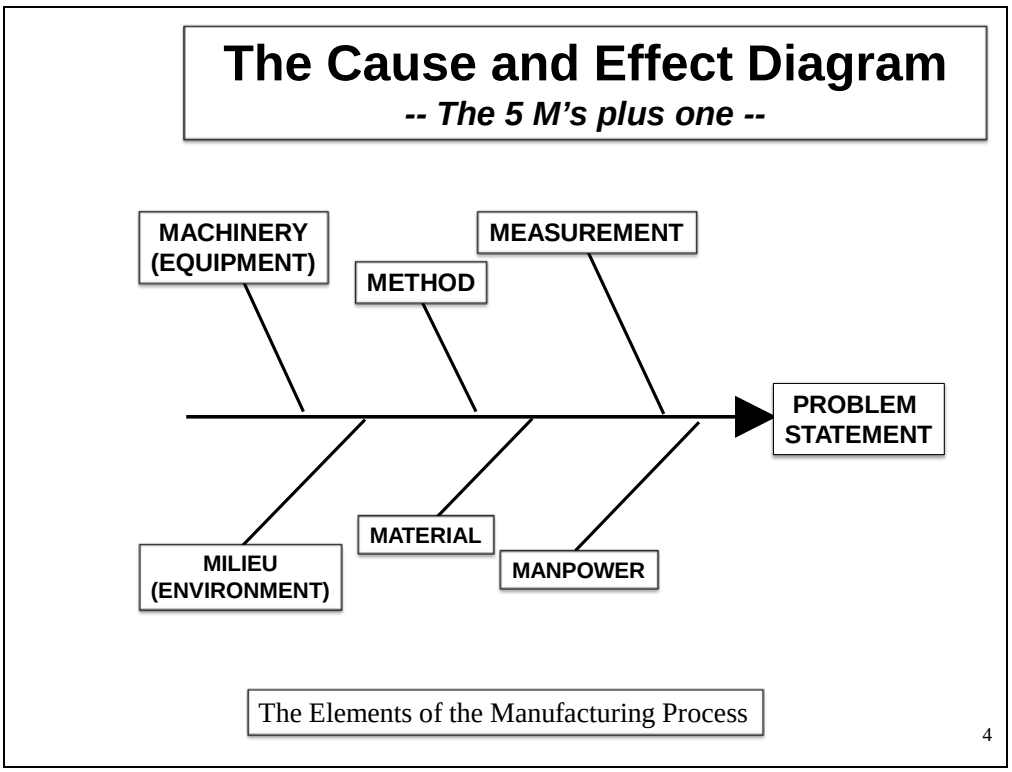
Weather during the flight was generally clear, but there were heavy gusting winds reported at low altitudes in the vicinity of the landing area

Assignment:

Using either the Fishbone/Cause and Effect diagram or the 5 Whys, identify, explore and display possible causes of this incident. After developing a list of as many possible causes as you can, use the multi-voting technique to narrow the possibilities down to the 3 most likely.

Hints:

- Be sure everyone agrees on the problem statement before beginning.
- Use the 5M's of manufacturing (**manpower, methods, material, machines and measurement**) as the major "cause categories" to get started. Feel free to add any other categories the team feels appropriate. Never let the Fishbone limit your investigations.
- Brainstorming is very useful for this kind of preliminary data gathering effort. In your team, put as many ideas down as possible.
- Be succinct.
- For each node, think: what could possibly be its causes? Add them to the bone.
- Pursue each line of causality back to its root cause.
- Consider grafting relatively empty bones onto others.
- Consider splitting up overcrowded bones.
- Remember that ideas can affect more than one category, i.e., they can be listed in several places. Remember to also list contributing factors to the causes (e.g., training).
- When the diagram is finished, consider which root causes are most likely to merit further investigation.

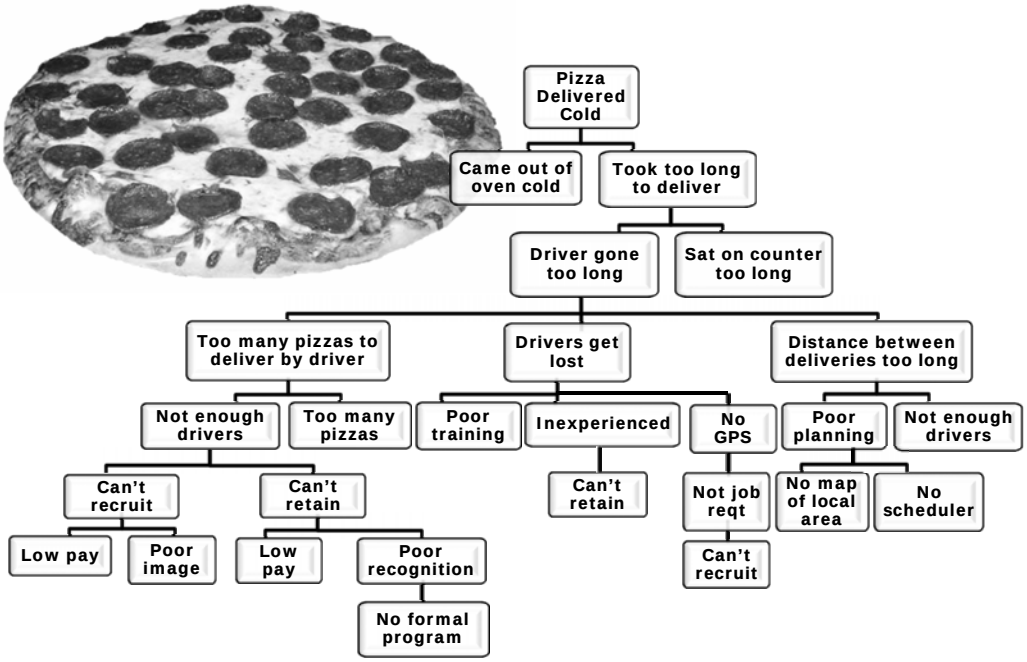


The 5 Whys

"By repeating why five times, the nature of the problem as well as its solution becomes clear."
-- Tachii Ohno, Architect of Toyota Production System

- **Question-asking method to explore cause / effect relationship and underlying issues**
  - Non-scientific approach – draws from opinions and observation of team
  - Confirm results with more robust analysis
- **Originally developed by Sakichi Toyoda**
  - Used within Toyota during evolution of manufacturing methodologies
- **"Five" is guideline not hard and fast rule**
- **Three key elements to effective use:**
  - Accurate, complete problem statement
  - Complete, unbiased, honest answers to each "why"
    - Most people tend to look away from themselves or their team
  - Determination to find root cause and not just symptoms
    - Correcting symptom wastes resources – correcting root cause get rid of problem permanently

The 5 Whys – Example



Multi-Voting

- **Narrows large list of possibilities to smaller list of top priorities**
- **Preferable to straight voting – allows item that is favored by all, but not top choice of any, to rise to top**
- **When to multi-vote:**
  - After long list of possibilities has been generated;
  - List must be narrowed down, and;
  - Decision must be made by group judgment
- **How to multi-vote (one variation):**
  - Display list of options, combining duplicate items
  - Working individually, members select a pre-determined number of items (typically 3-5) thought to be most important
  - Tally votes – votes can be prioritized and weighted, if desired
  - Repeat process if necessary to further reduce list of options
  - Further investigate and/or refine top vote-getters

Exercise

- **Each team will use one of the root cause investigation methods to brainstorm / identify potential root causes (20 minutes)**
- **After developing a list of possible root causes, team will use the multi-voting approach to narrow the list (5 minutes)**
- **Teams will brief their results, identifying the overall top 3 likely root causes to the accident (20 minutes)**

LESSON ASSIGNMENT SHEET

Lesson Number Exercise 4.4

Lesson Title Supportability

Lesson Time 2 hours

Terminal and Enabling Learning Objectives

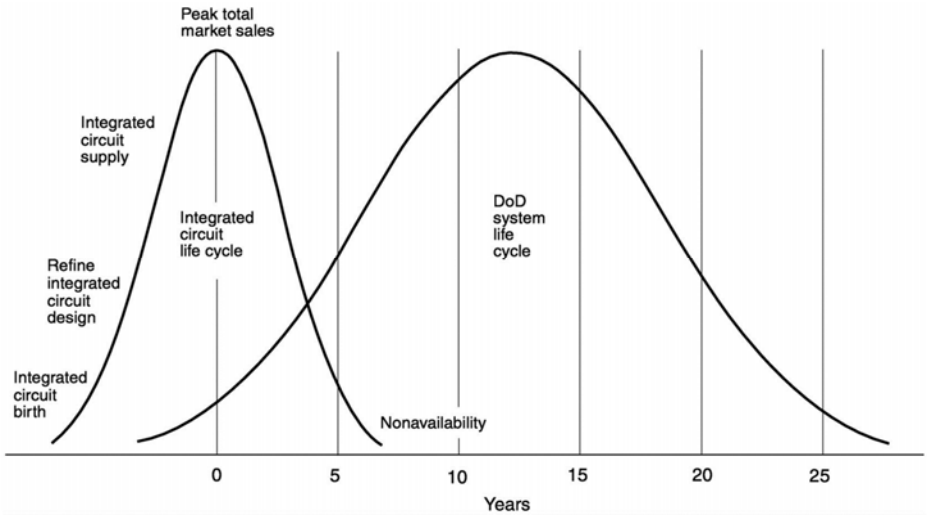
TLO		**Analyze the impact of supportability issues on system readiness/performance and other functional areas. E.g. contracts, finance, systems engineering and acquisition logistics**
	ELO	Synthesize several approaches to solving a program supportability issue (obsolescence).
	ELO	Evaluate approaches to solving a program supportability issue (obsolescence).
	ELO	Recommend the best to solving a program supportability issue (obsolescence).
	ELO	Identify the proper DoD Appropriation Category to be used to budget for each of the three phases of a Product Improvement Program.
	ELO	Assess the impact of the failure to execute funds in accordance with program plans.
	ELO	Recognize how configuration management impacts all functional disciplines (e.g., test, logistics, manufacturing, etc.)
	ELO	Demonstrate the interrelationship between selected functional areas, e.g., contracting, finance, systems engineering, and life cycle logistics.
	ELO	Identify tools/best practices/techniques available in the systems engineering process to achieve the principal goals of supportability analyses.
	ELO	Apply performance based metrics to a program supportability problem (e.g. obsolescence)
	ELO	Apply performance or outcome based logistics principles to solving a program obsolescence issue.

Assignments Review the following ACQ 202 CBT Lesson Summaries:

- Lesson 2.3, Developing the Life Cycle Sustainment Plan
- Lesson 3.3, Design for Supportability/Trade-Off Analysis
- Lesson 3.6, Role of Manufacturing

	• Lesson 6.2, Logistical Support
Estimated Student Preparation Time	30 minutes
Assessment	Class participation; oral presentation
Related Lessons	• Lesson 2.3, Developing the Life Cycle Sustainment Plan • Lesson 3.3, Design for Supportability/Trade-Off Analysis • Lesson 3.6, Role of Manufacturing • Lesson 6.2, Logistical Support
Self Study References	N/A

Obsolescence



So What Exactly is PBL?

Focuses system support on what's Important to the war fighter: capability and performance

- **Performance Based Logistics = Performance Based Life Cycle Product Support (PBL)**
- **A Life Cycle Management (LCM) implementation strategy**
- **An outcome-based product support strategy that plans and delivers an integrated, affordable performance solution designed to optimize system readiness**
- **Establishes performance goals for a weapon system through a support structure**
- **Based on long-term performance agreements with clear lines of authority and responsibility to continuously meet the users needs**
- ***Recommended Reading*: Oct 09 Defense ARJ Article "What PBL is and What it is Not; and What it Can and Cannot Do" http://www.dau.mil/pubscats/PubsCats/Kobren.pdf**

Fundamental PBL Tenets

PBL is NOT Outsourcing – it "is not synonymous with CLS nor does it require a private sector integrator" (AFI 63-107)

- **Produce OUTCOMES, not OUTPUTS!**
- **Performance as a package, vice transactional goods and services**
- **Document performance, support, & resource requirements in Performance Based Agreements (PBA)**
- **Establish Product Support Integrator (PSI) to integrate & manage all (contract and organic) sources of support**
- **Establish incentives to promote "win-win" relationships and achievement of performance outcomes**
- **Leverage Public-Private Partnerships to make best use of organic and commercial capabilities in long-term collaborative relationships**

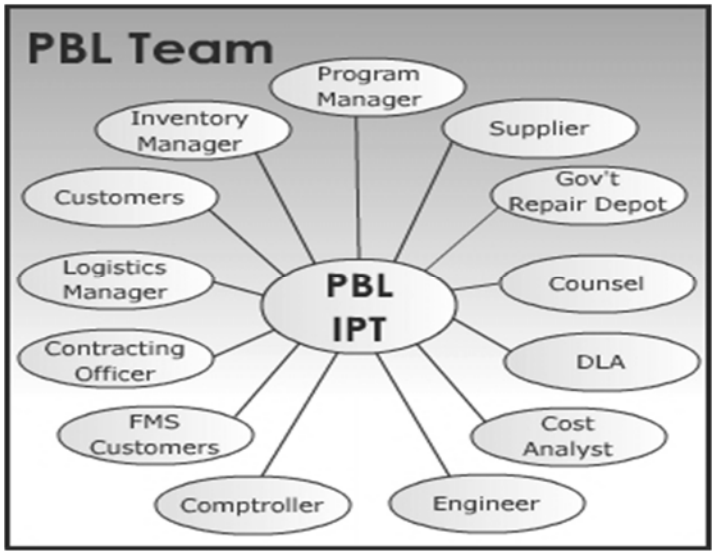
Why PBL Works

Focus on the Performance "End-State" … NOT the "How To"

- **DoD obtains comprehensive performance package**
  - Not individual parts, transactions, or "spares & repairs"
- **Approach totally reverses vendor incentive**
  - Fixed price "pay for performance" contracts motivate vendor to reduce failures/ consumption
  - Incentivizes "less I use, the more profit I can make" vice a "more spares and repairs I can sell, the more profit I can make" mentality
  - Long term commitment enables vendor to balance risk vs. investment
- **Improves Parts Support**
  - Material availability increases + Logistics Response Time (LRT) decreases resulting in Improved Readiness
- **Optimizes Depot Efficiency**
  - Repair Turn Around Time (RTAT), Awaiting Parts (AWP), & Work in Process (WIP) decrease
- **Incentive to Invest in Reliability**
  - Mean Time Between Failure (MTBF) improves
- **Incentive to Invest in DMSMS & Obsolescence Mitigation, Improve Repair Processes, Reduce Costs, and Support the Warfighter**

The PBL Team

The program office's logistics manager will most often perform the role of the statutorily required Product Support Manager.

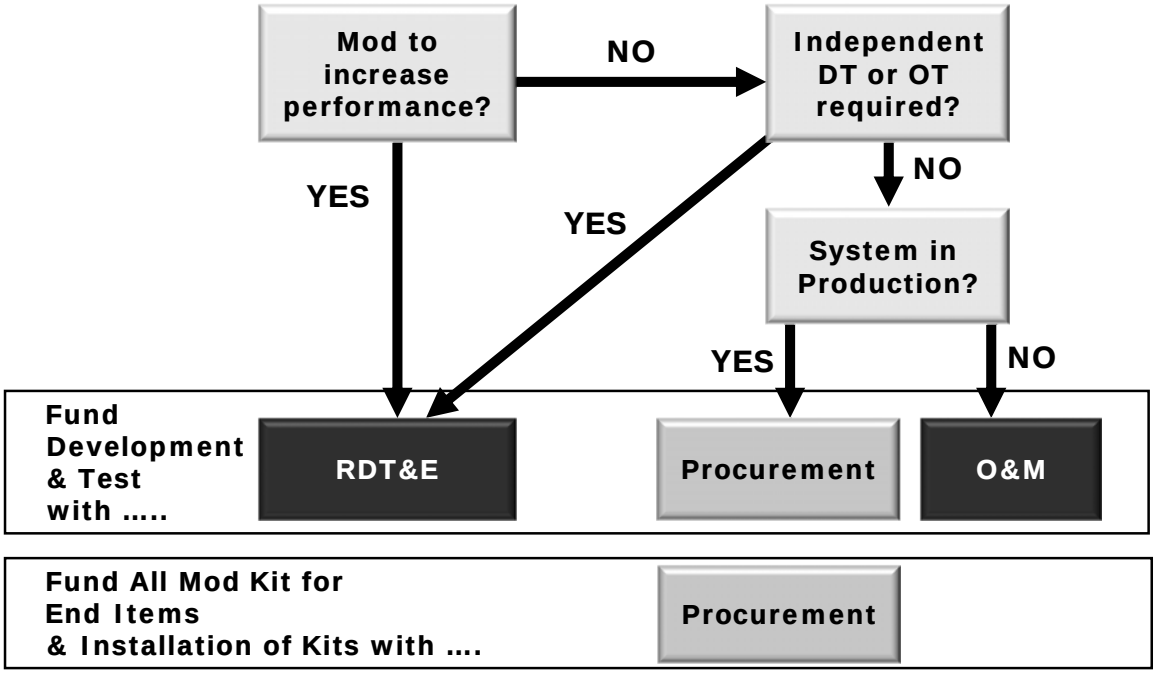


Support Performance "Outcomes"

These 4 Life Cycle Sustainment Outcome Metrics Are Universal Across All Programs And Are Essential To Effective Sustainment Planning

Requirement	Need	Performance Measure
Materiel Availability	Is the system ready?	• Mission Capability Rate • Reduced Down Time
Materiel Reliability	Will the system be effective?	• Mission Completion Rate (sorties, etc.) • Time on Wing • Mean Time Between Failures (MTBF)
Ownership Cost	How much will it cost?	• Operating Cost (per flight hour, mile, steaming hour, etc.)
Mean Down Time	How long does it take to meet the demand?	• Customer wait time • Mean Logistics Delay Time (MLDT) • Mean Time to Repair

Product Improvement Funding Decision Tree



Conclusion

- **The work of a program office is never done. Issues arise even after a system is fielded.**
  - Follow-on operational testing may reveal weaknesses in the system
  - Advancement may present opportunities to improve or extend the service life of the system
  - Logistical support can impact other functional areas such as contracting, funds management, configuration management and test & evaluation.
  - By taking a long-term view, considering total life-cycle costs, and using standardized components and open systems designs, we will make the most cost effective decisions.

Exercise 4.4, Firebird II Supportability

Firebird II has finally reached Full Operational Capability (FOC) when the item manager for the X-651 Field Programmable Gate Array (FPGA) integrated circuit chip announces that the chip has reached end of life. System Danner, the manufacturer of the FPGA states they will cease production of the X-651 in 12 months. The X-651 FPGA is used in the Firebird Inertial Navigation System (INS). The Air Force manages this stock item for all the services. Operational units order the INS through normal Air Force supply channels using O&M dollars.

The INS in which the X-651 is used is one of only a few original GFE items that remain from the original Firebird system. The INS was originally manufactured in accordance with a detailed specification provided by the Air Force and is used in all of the current Firebird and Firebird II fleet. System Danner, who has been the supplier of the chip to the INS manufacturer since the mid-1990's, is the sole supplier for the X-651.
The item manager sends an e-mail to Larry, the Logistics Manager in the Firebird II program office, to let him know about the FPGA situation. The item manager mentions that the manufacturer has a couple of possible solutions they would like to offer the Government:

- System Danner is willing to execute an " End of Life" buy, where the Government would be given priority to purchase the X-651's in a quantity that the Air Force believes would provide enough FPGAs to last for about 4 years beyond the current year assuming current usage rates.

- System Danner has also offered to sell the technical data package (TDP) for the integrated circuit if the Government wants to buy it, which would allow the Government the opportunity to find another manufacturer to make the X-651. The manufacturer is willing to allow the Government to purchase the TDP for approximately the same price as the value of the ICs on hand.

Larry, worried about the readiness impact, asks the item manager what the Air Force intends to do about the X-651 FPGA integrated circuits for their other UAVs. The item manager states that this isn't a problem for the Air Force as with the exception of Firebird, they haven't ordered any of these FPGAs for over a year now. Instead, the Air Force has been buying FPGAs for all their service unique UAVs using a performance specification. The performance specification uses open standard interfaces that specify standard FPGAs provided by lots of different vendors. This was part of an Air Force initiative several years ago to go to an open systems design for all of their UAVs to save money and support broader competition.

Upon further investigation, Larry learns that Firebird INS motherboard is the lowest replaceable assembly (LRA), and is unique in that newer FPGAs are not compatible. So, Larry has a supportability dilemma, and he needs your help to decide how best to ensure that the Firebird system has a viable INS for the future.

Assignment:

1. Identify three possible alternatives that could meet the services' requirements for Inertial Navigation System (INS) for Firebird II, given that the supplier will stop producing the FPGA within 12 months.

2. Select your choice among the alternatives and be prepared to explain why it is the alternative your team would recommend to the Logistics Manager.

3. Analyze your selected alternative in terms of the following considerations (if they apply) and the necessary actions that would need to be taken.

- Funding impacts
- Contracting impacts
- Configuration management issues
- Test and Evaluation impacts
- Supportability issues/concerns [i.e., RAM/Operational Availability (Ao)/Applicable Elements of Support]
- Manufacturing issues

4. Choose a performance based metric that you would use in the contract for your selected alternative.

5. Be prepared to brief your results of the above four steps to the class.

ACQ – 202

Intermediate Systems Acquisition Course

CBT Lesson Summaries

Lesson Summary

Considering the Costs

Learning Objectives

The following learning objectives are covered in this unit:

- Given an Initial Capabilities Document (ICD) and a summary Analysis of Alternatives (AoA), select an appropriate concept, from the perspective of the system developer, to meet the user's requirements.
- Given a cost breakdown, determine Development Cost, Flyaway Cost, Weapon System Cost, Procurement Cost, Acquisition Cost, and Life Cycle Cost.
- Select an appropriate method to estimate the cost of an acquisition program.
- Select an appropriate approach (e.g., Analogy, Parametric, Top-Down, Engineering (Bottom-Up), Actual, Delphi) to estimate the cost and schedule for a software-intensive system.
- Relate the typical distribution of software lifecycle costs to the planning of an acquisition program.
- Recognize the impact and interrelationship of life cycle product support and lifecycle cost.

Analysis of Alternatives (AoA)

An Analysis of Alternatives (AoA) is used to help select the best, most cost-effective way to meet a capability need. An AoA:

- Is a study of operational effectiveness and life-cycle cost
- Is mandatory for all acquisition category (ACAT) programs
- Provides objective feedback on cost and effectiveness of alternatives
- Is based on information from the Initial Capabilities Document (ICD), including:
    - Functional areas
    - Range of military operations
    - Time
    - Key attributes defined by measures of effectiveness

The AoA can be used to justify starting, stopping or continuing an acquisition program based on cost, performance and schedule factors.

Cost Estimation

Cost Estimation is an analysis of costs of hardware, software or services derived from historical cost, performance, schedule and technical data of similar items or services and performance, schedule, and technical data for the new system.

Methods used to prepare cost estimates include:

- **Analogy** - A new system or component is compared with a similar, existing system or component. Generally this type of analysis can be done quickly and inexpensively. Analogy estimates are commonly used early in the acquisition process, but are subjective and less precise than other methods.
- **Parametric** - Statistical analysis of a database of similar systems is used to develop a relationship between cost and one or more performance or design characteristics of the systems. The resulting Cost Estimating Relationship can then be used to estimate the cost of a new system. This method is inexpensive and used relatively early in the acquisition process. The cost estimating relationship is very useful in analyzing "what-if" scenarios, but it is only as valid as the statistical correlation and the database used to create it.
- **Engineering** (Bottom-Up) - Detailed analysis of all of the materials, parts and labor required to produce a system is performed from the bottom up. This analysis is very accurate and is more objective than other methods, but it can be expensive and very time-consuming. Engineering estimates are typically used for elements identified as cost drivers in the later stages of system development.
- **Actual Costs** - Costs of future efforts are extrapolated based on the previous cost of identical or nearly identical systems. This method also refers to the use of actual cost data from completed portions of the program to update the program's life cycle cost estimate.

Methods used to prepare cost estimates for software development include the analogy, parametric, and the bottom-up methods above, plus:

- **Top-Down** - a systems-level view of the project
- **Delphi** - a team of experts combine different approaches to arrive at a collective judgment.

Generally, a life cycle cost estimate will use a combination of different methods. The type of estimating method that is used on each of the cost elements that comprise the estimate should be based on the type and accuracy of available data, the stage of the acquisition life cycle, and the relative importance of the cost element. Each of these methods can be used independently or in combination.

Cost Terms and Definitions

Cost terms and definitions are provided in DoD 5000.4-M, and include seven types of acquisition-based costs:

- **Development Cost** - Cost of all research and development-related activities that are necessary to design and test the system. Funded with RDT&E appropriation.
- **Flyaway Cost** (a.k.a. rollaway) - Cost of producing prime mission equipment such as ships or tanks. Funded with procurement appropriations
- **Weapon System Cost** - Sum of flyaway cost and cost of associated support equipment and services (including initial training). Also funded by procurement appropriations.
- **Procurement Cost** - Sum of weapon system cost and cost of the system's initial spares. Funded with procurement appropriations.
- **Program Acquisition Cost** - All costs associated with developing, procuring and housing a weapon system. Procurement, RDT&E, and MILCON appropriations are used to fund this cost.
- **Operating and Support** - All costs for personnel, equipment, supplies, software, and services associated with operating, maintaining, supplying and providing ongoing training for any DoD

system. Most O&S costs are funded with the O&M and MILPERS appropriations, although procurement, RDT&E and MILCON appropriations may also be used when appropriate.

- **Life-cycle Cost** - Total cost of an acquisition program from beginning to end, including program acquisition, operating and support, and disposal costs.

All of these costs are funded by specific appropriations, generally referred to as "colors of money." As you recall from ACQ-101, the appropriations used by DoD generally fall under five categories:

1. Research, Development, Test and Evaluation (RDT&E)
2. Procurement
3. Operations and Maintenance (O&M)
4. Military Construction (MILCON)
5. Military Personnel (MILPERS)

Distribution of Life Cycle Cost

Generally, costs related to the Operation and Support of a system once it is fielded represent the largest proportion of its life cycle cost, generally between 70-80%, although the specific percentage varies by system type and service life. This holds true for software as well as hardware. The largest distribution of software costs will be late in the program's cycle. The primary costs of software are related to upgrades and the maintenance that it takes to keep the software running.

Lesson Summary

Selecting the Best Approach

Learning Objectives

The following learning objectives are covered in this unit:

- Determine the applicability of science and technology activities to the acquisition of a system.
- Relate the concepts of Affordability and Should Cost to the planning of an acquisition program.
- Given a draft Capability Development Document (CDD) and a summary Analysis of Alternatives (AoA), select an appropriate concept, from the perspective of the system developer, to meet the user's requirements.

Science and Technology

Science and Technology (S&T) provides the capabilities that give us combat advantages over our adversaries. S&T activities are divided into three groups based on funding activities: basic research, applied research, advanced technology development.

Basic Research

Basic Research (Budget Activity 1 funds) involves innovation and discovery aimed at increasing scientific knowledge. It is usually conducted at academic, laboratory, or other research facilities.

Applied Research

Applied Research (Budget Activity 2 funds) applies Basic Research findings to real-world problems in order to generate and test new technologies with potential military utility.

Advanced Technology Development

Advanced Technology Development (Budget Activity 3 funds) demonstrates the technology maturity and the military utility of completed applied research projects and provides realistic assessment of their potential for transition to an acquisition program. There are two types of demonstrations: Advanced Technology Demonstrations (ATDs) and Joint Capability Technology Demonstrations (JCTDs).

Advanced Technology Demonstrations (ATDs)

ATDs demonstrate the feasibility and maturity of new technology, and reduce technical risk and uncertainty, before that technology is incorporated in a formal acquisition program.

Joint Capability Technology Demonstrations (JCTDs)

JCTDs are used in the field to gain understanding and evaluate utility of technology, develop concepts of operation for that technology, and expedite delivery of new capabilities to combat forces. JCTDs promote the rapid transition of the new technology into the appropriate phase of a formal

acquisition program.

The point at which a JCTD enters the acquisition life cycle will vary depending on how much work remains to be done before production begins. A Management Plan, Transition Plan, and Funding Plan ensure that the necessary preparations are made to facilitate movement into the acquisition process without loss of momentum. The Transition Plan considers such issues as contracting strategy, supportability, test and evaluation, affordability and interoperability of the JCTD with other systems to ease the transition to a formal acquisition program.

Summary of Affordability and Should Cost information

Should Cost entails setting cost objectives that balance mission needs against projected out-year resources and making tradeoffs in performance and/or schedule to meet capability needs within available resources. Under the Should Cost approach, available funds are considered to be the independent variable or constraint, while performance and schedule may be adjusted (within thresholds established in the CDD) to determine the most cost effective and affordable solution to meet mission requirements.

- Should Cost performance tradeoffs are made within the trade space between thresholds and objectives established by the user and documented in the CDD.
- The user, developer and support communities must actively participate in the Should Cost process.
- Should Cost helps refine the CDD by determining what threshold and objective values should be associated with particular operational performance parameters.
- The best time to reduce life cycle cost is early in the acquisition process. However, Should Cost principles can be applied throughout the acquisition life cycle to achieve an affordable and effective system.

Lesson Summary

Integrated Product and Process Development (IPPD)

Learning Objectives

The following learning objectives are covered in this unit:

- Relate the key tenets of Integrated Product and Process Development (IPPD) to planning and executing an acquisition program.
- Identify the barriers to successful Integrated Product Team (IPT) implementation.
- Identify key acquisition best practices related to IPPD and IPT processes, including commercial practices that impact the relationship between government and industry.

IPPD Key Tenets

Integrated Product and Process Development (IPPD) stresses cross-functional communication throughout the acquisition process and includes the following key tenets:

- **Customer focused:** meet the customer's needs better, faster, and cheaper.
- **Concurrent development of products and processes:** processes used during all phases should be considered throughout product design and development.
- **Early and continuous life cycle planning:** should begin with science and technology efforts and extend throughout the entire acquisition life cycle.
- **Maximize flexibility for optimization and use of various contractor approaches:** contracts should be designed to allow contractors to apply IPPD principles and make use of effective commercial standards, practices, and processes.
- **Encourage robust design and process improvement capability:** techniques should be used that achieve quality through design, focus on process capability, and stress continuous process improvement.
- **Event-driven scheduling:** scheduling should relate program events to their respective accomplishments and accomplishment criteria.
- **Multidisciplinary teamwork:** decision-making should be based on input from the entire team, to reduce risk and create a work environment that is more likely to result in successful suggestions.
- **Empowerment:** team members should have the authority to make decisions at the lowest possible level commensurate with risk.
- **Seamless management tools:** a management framework should be established that helps show the interrelationship of all products and process.
- **Proactive identification and management of risk:** risk analyses and user needs should be evaluated to identify critical cost, schedule and technical parameters.

Integrated Product Teams

IPPD is implemented through Integrated Product Team (IPT) members who represent technical, business, and support functions. The following guiding principles will improve the productivity of any IPT:

- **Chartering, launch, and initiation:** To get the team off to a good start, prepare a charter documenting the mission, timeframe, and membership of the IPT; train participants in IPT principles and the role of each team member; and prepare a Plan of Action and Milestones (POA&M).
- **Goal alignment:** Team leaders should ensure that the goals and objectives of each team member are consistent with the goals of the project. Effective feedback mechanisms should be put in place to facilitate this.
- **Open discussions with no secrets:** Due to the unique design of IPTs, in which each member has expertise in a specific area, free and open communication among all members is essential.
- **Empowered, qualified team members:** Team members should have the authority to represent their superiors in the decision-making process. They should remain in close communication with their bosses to ensure their advice is sound and will not be changed later, barring unforeseen circumstances.
- **Dedicated/Committed, Proactive Participation:** Because team success hinges on participation by members with institutional knowledge of functional areas, IPTs should be organized so that all key stakeholders can contribute effectively. In many cases, this means minimizing membership to enhance communication and trust.
- **Issues Raised and Resolved Early:** All issues should be raised openly and discussed at the earliest possible opportunity, and solved through team consensus and discussion, not isolated conversations "offline."

IPPD Barriers

If IPPD is not implemented properly, barriers can arise that will impact the quality, effectiveness, and timeliness of the overall process. Some of these barriers include:

- **Lack of commitment from top management**, which can hurt team member motivation and impact their ability to achieve results.
- **Need for significant cultural change** due to the inherent hierarchical structure of the military, which contrasts with the philosophy set forth in the IPPD process.
- **Lack of adaptation to the IPPD process by functional organizations**, thereby reducing everyone's performance.
- **Lack of planning**, which causes teams to rush to catch up, thus impacting quality.
- **Poor or non-existent education/training** in the IPPD process.
- **No effort to identify and/or share best practices** in IPPD implementation.
- **A "not invented here" mentality** that can arise due to the many functional areas involved in the IPPD process, which leads to a lack of information sharing.
- **Contractually-imposed practices** that hinder a contractor's flexibility.

- **Use of IPPD by the contractor but not by DoD**, resulting in morale problems and less effective working relationships.
- **Awarding of contracts to traditional approach contractors** who are not familiar with the IPPD process, even if it is specified in the Request for Proposal (RFP).
- **Unrealistic promises** by contractor to implement IPPD.
- **Poor contract award fees or incentives** that don't encourage IPPD.
- **Poorly run meetings or reviews**, resulting in over-emphasis of a particular topic or functional area to the exclusion of others.

Version 1.1 (30 June 2015)

Lesson Summary

Developing the Acquisition Strategy

Learning Objectives

The following learning objectives are covered in this unit:

- Identify the information required for a decision review and recognize the significance of the Acquisition Program Baseline, Key Performance Parameters, and Acquisition Strategy.
- Identify the advantages and disadvantages of international armaments cooperative development in an acquisition strategy.

Key Performance Parameters (KPPs)

Key Performance Parameters (KPPs) are capabilities and characteristics considered by the user to be the most essential in successfully accomplishing a capability need. KPPs:

- Should be a minimum number of Performance Parameters necessary to adequately describe the required capability of the system (generally eight or fewer).
- Are defined using threshold and objective values as a way to describe performance capabilities.

While trade-offs among cost, schedule, and performance might have to be made during the program's life cycle, KPP thresholds are typically non-negotiable.

- **Threshold values** can be lower or higher than objective values, depending on the parameter involved. For example, for a lighter and faster vehicle, the threshold speed would be **lower**, and the weight **higher**, than the objective values.
- Threshold values establish the minimum acceptable operational value of a given parameter, below which the utility of the system becomes questionable.
- Unless otherwise specified, the objective value for performance is the same as the threshold value. For schedule, the threshold typically is the objective value plus six months, while the threshold cost typically is the objective value plus 10 percent.
- **Objective values** are the ideal performance parameters desired for the acquisition program, and are usually defined in operationally meaningful, time-critical, and cost-effective increments above the threshold values. Ideally, the difference between the threshold and objective values should diminish as the acquisition program advances.

Acquisition Program Baseline (APB)

The Acquisition Program Baseline (APB) establishes the cost, schedule and performance targets for an acquisition program. Specifically, the APB:

- Serves as a formal agreement between the Program Manager (PM) and the Milestone Decision Authority (MDA)
- Defines the space between the KPP objectives and thresholds in which trade-offs can be made between cost, schedule and performance without requiring MDA or user approval, as appropriate
- Can only be changed at milestone reviews, program reviews, or in the event of an unrecoverable APB breach

Performance Criteria

Only those performance criteria that influence operational effectiveness, suitability, cost and schedule should be included. In addition to program-specific threshold/objective values for performance, there are six mandatory Key Performance Parameters (KPPs) that must be addressed by each program: Force Protection; System Survivability; Training; Energy; Sustainment; and Net-Ready.

Schedule Parameters

Schedule parameters should include program initiation, major milestone decision points, initial operating capability (IOC) and other critical program dates.

Cost Constraints

This section of the APB shows program-related costs in base year dollars, based on careful risk assessment and cost estimating. The APB will also include affordability caps for unit production and sustainment costs.

Acquisition Strategy

Development of an Acquisition Strategy is usually done by an Acquisition Strategy IPT, which includes representation from all functional areas, end users, and key stakeholders. A well-defined acquisition strategy will include information on:

- **Contracting:** Number and types of contracts, timing, competition, potential sources, source selection approach, and Item-Unique Identification (IUID) implementation
- **Funding:** Type and year of appropriations, funding source agreements, and affordability analysis
- **Cost:** Cost objective and threshold values derived from Affordability goals, Should Cost objectives, and cost estimation activities for typical major cost metrics such as total RDT&E cost, total procurement cost, program acquisition unit cost, average procurement unit cost, and life cycle cost

- **Systems Engineering:** Technology and product solutions, including commercial and non-developmental items; open systems architectures; modeling and simulation; environmental, safety and occupational health considerations; baseline system performance thresholds and objectives; corrosion prevention and control; and interoperability
- **Test & Evaluation:** Types of testing, timing of testing, test articles including quantities and sources, modeling and simulation, and resources such as test ranges
- **Software development:** System integration, sources, re-use, open systems architecture, data rights, and computer resource life cycle management
- **Support Strategy:** Life cycle sustainment addressing design for supportability, all applicable support requirements, and Performance Based Logistics (PBL) approach
- **Production:** Design for producibility; low-rate initial production (LRIP) schedule; and production quantities, including long lead procurement items
- **Management:** Risk management, including planning, assessment, handling, and monitoring of cost, schedule and performance risk; earned value management reports, if required, to track contractor progress; and any international considerations related to the program

Much of this functional information can be found in the Program Structure Chart, used to show specific dates for critical events, including acquisition program phases, decision milestones, program and technical reviews, major deliveries, T&E periods, RFP/contract information, and other important scheduling information.

The sequence and interrelationship of activities as the team progresses through the acquisition program is of significant importance in the program structure chart. The program structure chart should be consistent with the schedule parameters in the APB. The demonstration of program interrelationships is at the heart of the IPT approach, where actions and expertise of each team member can either help or hinder the team's overall ability to deliver a successful end product.

Remember, as in any IPT-based program, the team can be made up of different members depending on the nature of the acquisition program itself, and the expertise needed to make it successful. Because the Firebird is an ACAT II program, the management chain will include the PM, the Program Executive Office, and the Army Service Acquisition Executive (SAE). The ARMY SAE will be acting as the MDA.

International Cooperation

International Cooperation involves the collaboration of foreign governments and related organizations during any stage of the acquisition cycle. Congress requires DoD to determine if there are allied or other friendly nations with whom we can cooperate on major systems development. Also, the acquisition strategy should address the potential for international cooperative research, development, production, logistics support, or sale. Some of the possible attractions of international involvement include:

- A foreign government sharing in the cost of development
- An opportunity to incorporate emerging technology from abroad
- Possible lower production costs through increased foreign competition, by encouraging international producers to compete with domestic sources
- Promoting interoperability of our systems with those of our allies, providing a warfighting advantage in multi-national warfighting coalitions

Some of the possible problems with international involvement include:

- Political differences or economic problems with partners that can delay programs
- Possible dependency on foreign sources
- Security issues associated with technology transfer between countries can take a long time to resolve, which can lead to program delays
- Economic considerations for the US industrial base when foreign competition is introduced
- Legal and administrative requirements for international participation including coordination with the State Department

Version 1.2 (30 September 2015)

Lesson Summary

Developing the Life Cycle Sustainment Plan

Learning Objectives

The following learning objectives are covered in this unit:

- Identify long term supportability and sustainment strategies through the application of the Product Support Business Model (PSBM).
- Capture the Product Support Strategy and specific planning and execution details in the Life Cycle Sustainment Plan (LCSP).

Product Support Business Model (PSBM)

Hierarchical Framework

The PSBM defines the hierarchical framework in which the planning, development, implementation, management, and execution of product support for a weapon system component, subsystem, or system platform will be accomplished over the life cycle. The PSBM effectively describes the methodology by which DoD intends to ensure achievement of optimized product support through balancing maximum weapon system availability with the most affordable and predictable total ownership cost.

Roles and Responsibilities

The Program Manager (PM) –

The PM is assigned Total Life Cycle Systems Management (TLCSM) responsibility and is accountable for the implementation, management, and oversight of all activities associated with development, production, sustainment, and disposal of a system across its life cycle. As part of this, the PM has the responsibility to develop an appropriate sustainment strategy to achieve effective and affordable operational readiness consistent with the Warfighter resources allocated to that objective.

The Product Support Manager (PSM) –

Consistent with 10 USC 2337, all weapons system programs are required to have a PSM, and the PSM is delegated responsibilities for oversight and management of the product support functions. The PSM then typically leads the development, implementation, and top-level integration and management of all sources of support to meet Warfighter sustainment and readiness requirements.

Product Support Implementing Agents –

Consistent with the model's emphasis on PBL and a performance/outcome based product support approaches, there may be a requirement for one or more Product Support Integrators (PSI) who are chartered with integrating sources of support from Product Support Providers (PSP) (public or private), defined within the scope of their implementing arrangements, to achieve the documented outcomes.

Product Support Strategy Alternatives

Product Support Levels –

Product support may be categorized into three levels select each one for more information: system, subsystem, and component,

> ***System*** - A "system" is defined as a weapons platform, such as a tactical aircraft, an M1 Abrams tank, or an AEGIS ship (there are circumstances where a system may house or support another system managed by a different PM).
>
> ***Subsystem*** - A "subsystem" is an integrated critical subsystem that is part of a war fighting platform, such as an aircraft engine, a ground tactical vehicle fire control system, or on-board radar.
>
> ***Component*** - A "component" is generally defined as an item that can be readily removed and replaced. Components can be repairable assemblies or a commodity item requiring little or no repair, such as aircraft tires.

Integrated Product Support (IPS) Elements–

The range of product support is generally defined by the scope of the IPS elements. A listing of the twelve IPS elements is included below:

1. Product Support Management
2. Design Interface
3. Sustaining Engineering
4. Supply Support
5. Maintenance Planning & Management
6. Packaging, Handling, Storage, and Transportation (PHS&T)
7. Technical Data
8. Support Equipment
9. Training and Training Support
10. Manpower and Personnel
11. Facilities & Infrastructure
12. Computer Resources

These items are addressed in more detail in the IPS Element Guidebook: https://acc.dau.mil/ips-guidebook.

12-Step Product Support Strategy Process Model

Process Overview –

The development of, or revision to, a product support strategy follows the logical methodology captured in the 12-step model. The 12-step Product Support Strategy Process Model represents the major activities required to implement, manage, evaluate, and refine product support over the life cycle. It is not a rigid one-time process, but rather a flexible continuing, iterative process in which the sustainment of a system (or systems) is adapted and evolved to optimally support the needs and requirements of the Warfighter in an effective and affordable manner. The first two steps set the stage and set each program up for success:

Step One – Integrate Warfighter Requirements and Support

Understanding Warfighter requirements in terms of performance is the essential first step in developing a meaningful support strategy.

Step Two – Form the Product Support Management Integrated Product Team

Effective performance based product support strategies require the participation and consensus of all stakeholders in developing the optimum sustainment strategy. Establishing the Integrated Product Team (IPT) team, led by the PSM, is also a critical step in the Product Support Strategy Process Model.

Details on the remaining steps and other information about the Product Support Strategy Process Model is the PSM Guidebook: https://acc.dau.mil/psm-guidebook.

Life Cycle Sustainment Plan (LCSP)

Format –

The LCSP is to be a streamlined document consistent with the attached annotated outline. The outline is designed to be a tool for programs to effectively and affordably satisfy life-cycle sustainment requirements. This plan articulates the product support strategy, and it must be kept relevant as the program evolves through the acquisition milestones and into sustainment. The LCSP outline emphasizes early-phase sustainment requirements development and planning, focuses on cross-functional integration - most critically with systems engineering - and highlights key sustainment contract development and management activities."

The annotated LCSP outline is available on the DAU website at the following address: https://acc.dau.mil/lcsp-outline.

Overview

An overview of the product support strategy and sustainment-related arrangements shall be included in the Acquisition Strategy, to include information regarding performance based arrangements (both contracts and intra-Governmental agreements). Also, there must be alignment among the LCSP and other critical program documents, including the Systems Engineering Plan, and Technical Data Rights Strategy. It should also be noted that the Sustainment Quad Chart is the primary vehicle for summarizing the program's product support planning to stakeholders outside the program, and the LCSP must support and provide the detail behind the summary information presented on the chart.

Requirements

Public law 10 USC §2337 requires that the PSMs of major weapon systems e responsible for developing the product support strategy to be included in the LCSP.

DoD Instruction (DoDI) 5000.02 requires that a LCSP be developed and provided as part of the program approval process to document how the sustainment strategy is being implemented.

DoDI 5000.02 also provides the following information regarding the LCSP:

a. The Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)) will approve acquisition category (ACAT) ID, ACAT IAM, and USD(AT&L) - designated special interest program LCSPs at each decision point.

b. The Component Acquisition Executive (CAE), or designee, will approve LCSPs for ACAT IC, ACAT IAC, and ACAT II and below programs at each acquisition decision point after the Materiel Development Decision.

c. The LCSP will be updated at each decision point to reflect the increased maturity of the product support strategy, any changes in the corresponding product support package, current risks, and any cost reduction activities.

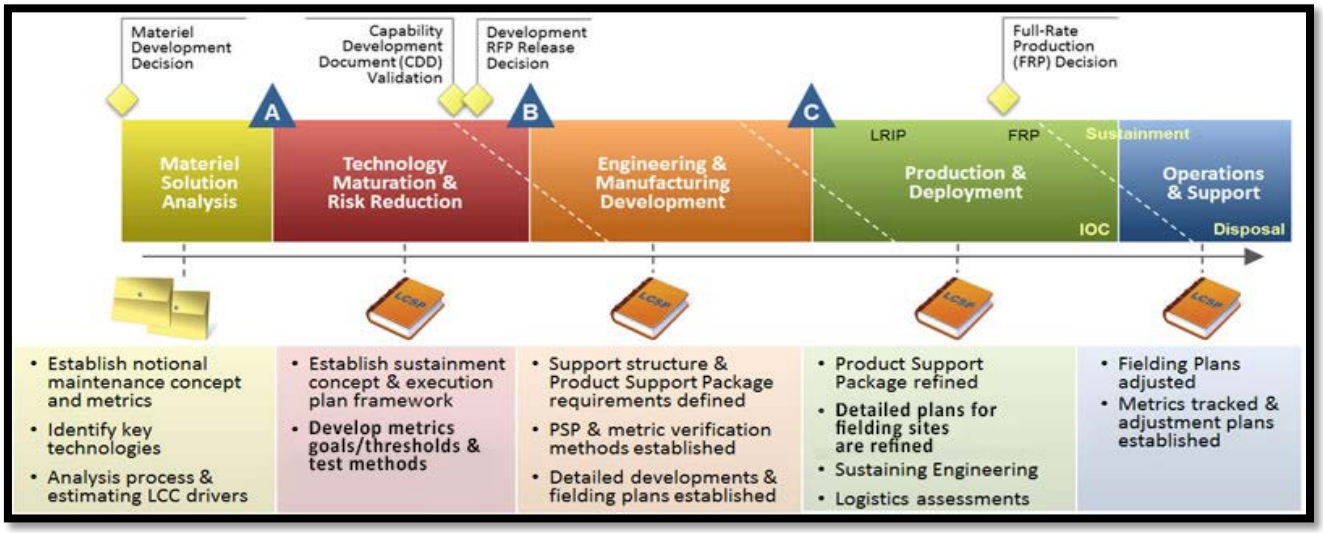
The **Defense Acquisition Guidebook (DAG) Section 5.1.2.2** states that the LCSP is a living document describing the approach and resources necessary to develop and integrate sustainment requirements into the system's design, development, testing and evaluation, fielding and operations.

Performance Based Logistics

DoD 5000.02 also requires that programs employ effective PBL planning, development, implementation, and management in developing a system's product support arrangements. PBL (also known as performance-based life-cycle product support) ties objective metrics delivered logistical system performance to incentives that will motivate the support provide.

Living Document

As depicted in the graphic below, requirements for LCSP content change over time, starting at Milestone A and continuing through the Operations and Support phase (**NOTE**: Review the links on Page 14, LSCP Evolution Tab, for more detailed information about the purpose/content of the LSCP at various points).



Milestone A – Focus on development of sustainment metrics to influence design and product support strategy, and on actions that can be taken before Milestone B to reduce future operating & support costs.

DRFPDR & Milestone B – Focus on finalizing the sustainment metrics, integrating sustainment considerations with design and risk management activities, and refining the execution plan.

Milestone C – Focus on ensuring operational supportability and verifying performance.

FRP Decision or Full Deployment – Focus on how sustainment performance is measured, managed, assessed and reported.

Initial Operational Capability (IOC) – LCSP will be principle document governing the system's sustainment.

Lesson Summary

Risk Management

Learning Objectives

The following learning objectives are covered in this unit:

- Identify the five activities of the risk management process model.
- Use the risk assessment process to identify the major areas/sources of risk in an acquisition program strategy.

Risk Management Process Model

The **Risk Management Process** has five activities designed to help identify and manage risk during the acquisition process:

Risk Planning

The first activity in the risk management process is to conduct risk planning, i.e.; completion of the activities to develop, implement, and document the risk management process. Effective planning should outline each of the risk management steps and should be summarized in the System Engineering Plan (SEP) and the Risk, Issue, and Opportunity (RIO) Management Plan (these three items may be captured in separate documents).

This activity answers the question, *What is the program's risk management process?* This activity determines what planning, budget, requirements and contractual changes are needed, provides a coordination vehicle with management and other stakeholders, directs the integrated product teams to execute the defined, and approved risk mitigation plans, outlines the risk reporting requirements for on-going monitoring, and documents the change history.

Risk Identification

The second activity in the risk management process is to identify risks by answering the question, *What can go wrong?* This step involves examining the technical aspects of a program to determine risk events (root causes) that may have negative cost, schedule, and performance impacts. To help identify risk root causes, the program team should ask "why" the event or condition is a risk, and then repeat the question "why" to reveal the causal factors that lead to the underlying root cause. The team continues the activity until it identifies the risk root cause as well as the specific causal factors.

Risk identification begins as early as possible in successful programs and continues throughout the program with regular reviews and analyses of Technical Performance Measurements (TPMs), schedule, resource data, life-cycle cost information, Earned Value Management (EVM) data/trends, progress against critical path, technical baseline maturity, safety, operational readiness, and other program information available to program IPT members.

Risk Analysis

Risk analysis answers the question, *How big is the risk? or What are the likelihood or consequence of the risk?* It is an iterative process that examines the cost, schedule, and performance parameters of risks in order to determine their likelihood and consequence to achieving program objectives. This activity examines each identified risk to refine the description of that risk, isolate its cause, determine the effects, and aid in setting risk mitigation priorities. Risk analysis refines each risk in terms of its likelihood, its consequence, and its relationship to other risk areas or processes. Analysis begins with a detailed study of the risks that have been identified. The objective is to gather enough information about future risks to judge their root causes, their likelihood, and their consequences, if the risk occurs.

Risk Handling

Risk handling includes the handling options or combination of options and the specific implementation approach to addressing risks. A risk handling approach answers the question, *What is the plan to address the risk?* or *Should the risk be accepted, avoided, transferred, or mitigated?* After the program's risks have been analyzed, the program personnel should develop a strategy to manage risks by evaluating the four risk handling options and selecting those best fitting the program's circumstances. The selected handling approaches for program-level risks should be reflected in the program's SEP and Acquisition Strategy and include the specifics of what should be done, when it should be accomplished, who is responsible, the cost, schedule, and performance impact, and the funding/resources required to implement the risk handling plan. The most appropriate program approach is selected from the handling options listed below and documented in a RIO mitigation plan. One or more of these handling options may apply:

- Risk Acceptance – Program acknowledges risk event or condition may be realized – risk should be continued to be tracked to ensure that accepted consequences do not change.
- Risk Avoidance – Program reduces or eliminates the risk event or condition by taking an alternate path, i.e., eliminates the source of the risk and replaces it with a lower risk solution.
- Risk Transfer – Program is able to reassign the risk responsibility to another entity (could be to another program, to the prime contractor, to another Government agency, etc.). Programs should recognize that transference of the risk does NOT eliminate all responsibility and the risks must still be monitored for potential consequences.
- Risk Mitigation – Program actively seeks to reduce risk to an acceptable level. This option generally entails taking action to reduce likelihood, and at times the consequence, of a risk to as low as possible to minimize potential program impacts.

Risk Monitoring

Risk monitoring answers the question, *How has the risk(s) changed?* Risk monitoring includes a continuous process to systematically track and evaluate the performance of risk mitigation approaches against established metrics throughout the acquisition process. During this time, the program office should reexamine and conduct assessments with the risk mitigation approaches to determine effectiveness.
Successful risk monitoring includes timely, specific reporting procedures as part of effective communications among the program office, contractor, and stakeholders.

Program Risk Areas

The risk management process should be integrated with other program management and systems engineering functions and associated tools during all phases of the program. Examples of program

management tools include the Work Breakdown Structure (WBS), Integrated Management Plan (IMP), Integrated Master Schedule (IMS) and Earned Value Management (EVM). Technical Performance Measures (TPMs) are an example of a relevant systems engineering tool.

Framing Assumptions and Ground Rules

Program leadership should consider and document program framing assumptions because of the risks they may introduce should the assumptions prove invalid. Examples of framing assumptions may include priority of requirements, schedule dependencies, or accuracy of models and simulations. In addition, the program should document key risk management ground rules to be used across the risk management program.
Typical ground rules for risk management relevant to programs include time frame, time of risk event, and WBS level:

- **Time Frame:** Current probability and impact estimates are based upon the status of the item or event as assessed, not upon projected or planned activities.
- **Time of Risk Event:** In order to properly analyze a risk, the time at which the risk hypothetically will occur should be considered and documented, as occurrence or realization timing is most likely a primary factor in the impact.
- **WBS Level:** Hardware and software risk events should be identified to the lowest level possible to facilitate identification of causal factors and handling strategies.

Potential Risk Areas

Program Risk Areas can come in a variety of forms from any functional area. These potential sources of risk include:

- **Threat:** Foreign intelligence collection efforts, program uncertainty due to changes in the threat, and degree of change in system design.
- **Capability Needs:** Level of sensitivity to uncertainty in user needs.
- **Design:** Ability of program's system configuration to meet objectives based on available tools, technology, etc.
- **Capability Needs:** Level of sensitivity to uncertainty in user needs.
- **Design:** Ability of program's system configuration to meet objectives based on available tools, technology, etc.
- **Test and Evaluation:** Capability of the T&E program to assess performance specifications.
- **Modeling and Simulation (M&S):** Capability of M&S to support program using validated models and simulations.
- **Technology:** May change rapidly during the program's life; opt for mature technology that has been demonstrated and can meet the program's objectives.
- **Logistics:** Ability of system configuration to meet logistics objectives.
- **Sources of Support:** Ability of the support strategy to ensure the system will be operationally suitable in its intended environment.
- **Production:** How well program production objectives can be met based on system design and manufacturing processes.
- **Concurrency:** Sensitivity to uncertainty resulting from poorly-planned life cycle phases or activities.
- **Capability of Developer:** Developer's ability to design, develop and manufacture the system.
- **Cost / Funding:** Achieving objectives within given resource and funding parameters.
- **Management:** Degree to which program plans and strategies can meet objectives.
- **Schedule:** Can the program accomplish its goals within a reasonable time frame?

The PMO should also be advised of risk in areas including, but not limited to, manpower, environmental impact, systems safety/occupational health, and systems engineering. Within an IPT, it is each team member's responsibility to best identify these potential risks within their area of expertise, and help develop consensus on how to tackle them before they grow unchecked.

Cybersecurity and the Risk Management Framework (RMF)

Department of Defense (DoD) systems increasingly depend upon complex, interconnected information technology (IT) environments. These environments are inherently vulnerable, providing opportunities for adversaries to compromise systems and negatively impact DoD missions. Potential cyber vulnerabilities, when combined with a determined and capable threat, pose a significant security problem for the DoD and its warfighters.

Cybersecurity is a special area of risk that requires an added emphasis and in fact has separate and complementary policies to govern its implementation and management. The management of the inherent risks associated with Information Systems (IS) and Platform Information Technology (PIT) is now captured in the program's Cybersecurity Strategy (required at Milestone A) as part of the overall Program Protection Plan (PPP). Platform IT is defined as information technology, both hardware and software, that is physically part of, dedicated to, or essential in real time to the mission performance of special purpose systems.
DoD Instruction (DoDI) 8500.01, *Cybersecurity*, defines the policy and procedures for cybersecurity. Cybersecurity is defined as the prevention of damage to, the protection of, and the resto-ration of computers, electronic communications systems, electronic communications services, wire communication, and electronic communication, including information contained therein, to ensure their availability, integrity, authentication, confidentiality, and nonrepudiation.

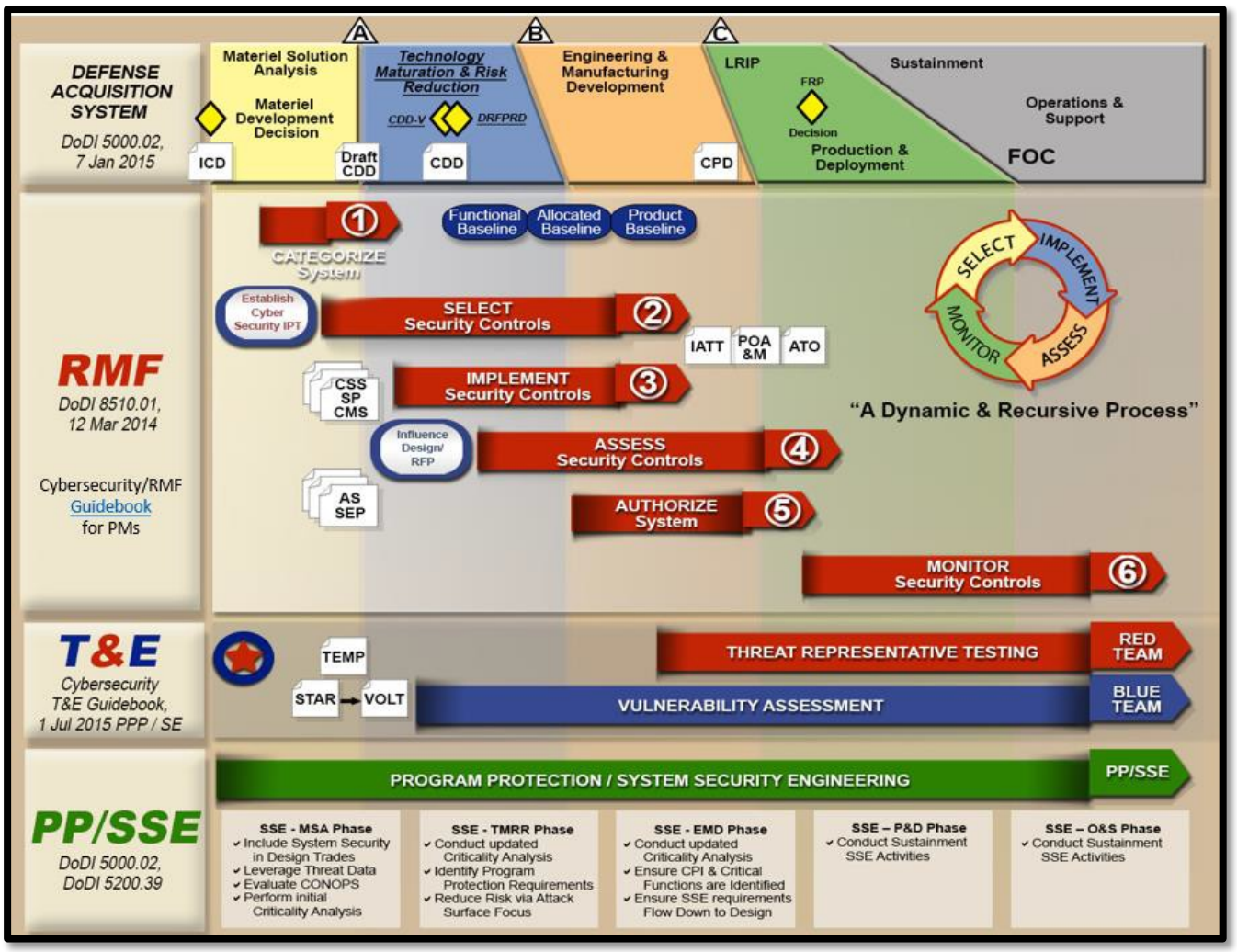
The RMF consists of six steps that fully integrate information security into the DoD enterprise architecture and system development life cycle. The steps provide a common set of security controls that promote reciprocity and reuse of test results and assessment documentation as a norm, thus saving time and resources while enhancing interoperability. The RMF describes the DoD process for identifying, implementing, assessing, and managing cybersecurity capabilities and services, expressed as security controls, and authorizing the operation of IS and PIT systems.

The RMF is designed to be complementary to and supportive of DoD's acquisition management system activities, milestones, and phases. RMF activities should be initiated as early as possible in the DoD acquisition process to increase security and decrease cost. Requirements development, procurement, and T&E processes should be considered in applying the RMF to the acquisition of DoD IT. The diagram on the following page shows the cybersecurity and acquisition life cycle integration.

Key Cybersecurity Acquisition Documents

Cybersecurity Strategy (formerly Information Assurance Strategy) – The Program Manager (PM) prepares the Cybersecurity Strategy and appends it to the PPP. The Cybersecurity Strategy includes cybersecurity requirements, approach, testing, shortfalls, and authorization for the system being acquired and the associated development, logistics, and other systems storing or transmitting information about that system. The Cybersecurity Strategy also helps facilitate consensus among PM, Component CIO, and DoD CIO on pivotal issues.

Program Protection Plan – The PPP is the integrating process for managing risks to advanced technology and mission-critical system functionality from foreign collection, de-sign vulnerability, or supply chain exploit/insertion, and battlefield loss throughout the acquisition life cycle. Program Protection is the Department's holistic approach for delivering trusted systems throughout the acquisition process during design, development, delivery, and sustainment. The scope of information includes information that alone might not be damaging and might be unclassified, but that in combination with other in-formation could allow an adversary to clone, counter, compromise, or defeat warfighting capability.



Version 1.2 (31 December 2015)

Lesson Summary

Developing the TEMP

Learning Objectives

The following learning objectives are covered in this lesson:

- Identify the primary test and evaluation (T&E) products required at each acquisition milestone.
- Identify the key T&E support organizations within DoD.
- Identify the key Operational Test and Evaluation (OT&E) activities that must be coordinated with the Director, Operational Test and Evaluation (DOT&E) staff and the Operational Test Agencies (OTAs).
- Identify the requirements for interoperability testing.
- Recognize how the Test and Evaluation Master Plan (TEMP) generation, staffing and approval process integrates all functional disciplines throughout the acquisition life cycle.
- Identify issues affecting T&E resource requirements, test planning, and test execution activities in support of a program's acquisition strategy.

TEMP Purpose

The **Test and Evaluation Master Plan** (TEMP) outlines the structure and objectives of the test and evaluation program. It must be developed by and staffed with a wide variety of functional experts to ensure the plan addresses all necessary technical, business, and resource issues. Moreover, the TEMP links together, and must be consistent with, a number of related program documents such as the:

- Initial Capabilities Document (ICD)
- Analysis of Alternatives (AoA)
- Capability Development Document/Capability Production Document (CDD/CPD)
- Acquisition Program Baseline (APB)
- Acquisition Decision Memorandum (ADM)
- Systems Threat Assessment (STA)

The TEMP is required at Milestone A and must be updated periodically to ensure that it stays current and integrates the various disciplines as the program evolves through the life cycle. At a minimum, these updates would coincide with subsequent milestones and other major decision reviews.

TEMP Information

The TEMP is mandated by DoD policy. The recommended TEMP format contains the following information:

- Four parts that serve as a starting point for organizing a successful test and evaluation program: System Introduction, Test Program Management Schedule, Test and Evaluation Strategy and Resource Summary.
- Critical Technical Parameters (CTPs) are key parameters and developmental testing criteria that are derived from Warfighter capabilities specified in the Capability Development Document (CDD) / Capabilities Production Document (CPD), and from technical performance measures as specified by the System Engineering Plan. The CTPs are developed, coordinated and approved by the T&E Integrated Product Team (IPT) within the Program Management Office. Examples of CTPs are an aircraft's engine thrust, cruising speed, range and altitude. CTPs are measurable criteria that, if not achieved during DT&E, preclude fulfillment of desired operational performance capabilities.
- Measures of Effectiveness (MOEs), which are used to determine the degree to which the system performs its mission.
- Measures of Suitability (MOSs), which are used to determine the degree to which the system is usable in its intended environment.
- Critical Operational Issues (COIs), which are questions used to address the operational effectiveness and suitability of the system to perform its mission.

Types of T&E

Test and evaluation falls into several categories including developmental, operational, live fire, and interoperability. Each plays a different role within the acquisition life cycle.

Developmental Test and Evaluation (DT&E):

- Is an integral part of the systems engineering process.
- Is conducted throughout design and development to ensure the system attains Critical Technical Parameters (CTPs).

Operational Test and Evaluation (OT&E):

- Helps determine system operational suitability and effectiveness.
- Addresses Critical Operational Issues (COIs) that are defined by the user.

Whenever possible, the Program Manager and test team should try to integrate DT and OT to save both cost and schedule time that would otherwise be lost in a serial testing process.

Live Fire Test and Evaluation (LFT&E):

- Determines survivability of crew and/or system vulnerability.
- Confirms lethality of munitions/missiles against intended target set.

Interoperability Testing

- Confirms interoperability requirements have been met.

Milestone Test-Related Products

Various test-related products are required prior to each milestone decision:

Milestone A

- Approved TEMP

Milestone B

- Updated and Approved TEMP
- Identification of LRIP Quantities
- Live Fire T&E Waiver (when required)
- Early Operational Assessment (EOA) results (when required)
- DT&E Report

Post Critical Design Review Assessment

- Early Operational Assessment (EOA) results (when required)

Milestone C

- Updated and Approved TEMP
- DT&E Report
- Operational Assessment results

Full Rate Production Decision Review

- Updated and Approved TEMP
- DOT&E Report on IOT&E
- Live Fire T&E Report
- Interoperability Certification

Developmental T&E Support Organizations

There are four key developmental T&E support organizations within DoD:

- Army Test and Evaluation Command (ATEC)
- Navy Systems Commands (NAVAIR, NAVSEA, SPAWAR)
- Marine Corps Systems Command (MARCORSYSCOM)
- Air Force Materiel Command (AFMC)

Operational T&E Support Organizations

There are several key operational T&E support organizations within DoD:

- Army Test and Evaluation Command (ATEC)
- Navy Operational Test and Evaluation Force (OPTEVFOR)
- Marine Corps Operational Test and Evaluation Activity (MCOTEA)
- Air Force Operational Test and Evaluation Center (AFOTEC)

Interoperability Capabilities

Most systems today must be able to exchange information with other systems. For example, joint and combined military operations require National Security Systems (NSS) that are interoperable across the services and compatible with our allies. DoD acquisition policy requires such systems to establish a Net-Ready Key Performance Parameter (NR-KPP) that identifies specific interoperability capabilities. The NR-KPP ensures that the systems are able to:

- Provide and accept data, information, materiel, and services from other systems, units or forces
- Use interchangeable systems that operate effectively together
- Exchange information directly between themselves and/or their users

The program's NR-KPP (requirement for interoperability capabilities) must be certified and validated by the Joint Staff. Once the capability need is validated, the performance of the systems must be tested to ensure that they meet the established interoperability capability needs. The Joint Interoperability Test Command (JITC) assesses system interoperability performance and certifies full end-to-end interoperability of systems upon successful completion of the testing.

Lesson Summary

Environment Safety and Occupational Health Issues

Learning Objectives

The following learning objectives are covered in this unit:

- Identify the information required for a milestone review regarding environment, safety, and occupational health issues.
- Identify key federal and DoD policies governing environment, safety, and occupational health issues associated with defense systems acquisition.

PESHE

There are many federal laws, Executive Orders, and other guidelines designed to minimize an acquisition program's impact on the environment. To ensure awareness, proper planning, and compliance, the Programmatic Environment, Safety, and Occupational Health Evaluation, usually referred to as PESHE, is an acquisition policy requirement for all ACAT programs. Support for a PESHE requires analyses in the following areas:

- ESOH Compliance- describes procedures for determining compliance, defines compliance requirements, and analyzes impact of compliance on the program's cost, schedule and performance.
- Safety and Occupational Health - describes procedures used to identify and eliminate hazards, defines risk levels, and summarizes the impact of potential health and safety hazards, including loss of life or program units.
- Hazardous Materials Management - outlines the goals of the hazardous materials program and related issues, and includes the process for identifying, tracking, handling and disposing of hazardous materials that cannot be eliminated.
- Pollution Prevention - describes pollution prevention initiatives and process for preventing or minimizing impacts on natural resources.
- National Environmental Policy Act - NEPA requires preparation of detailed statements on major federal actions significantly affecting the quality of the human environment.

The order of priority for handling hazardous materials is as follows:

1. **Source reduction/elimination** by using alternative materials or processes.
2. **Recycling** or purification and reuse of material.
3. **Treatment** to neutralize waste products so that they are no longer hazardous.
4. **Disposal** through burning, landfills, or other means.

As a last resort, PMs can use remediation to clean up material that was improperly disposed of.

NEPA

The National Environmental Policy Act (NEPA) requires program managers to evaluate the environmental impact of an acquisition program before making major decisions that could affect the environment. It must be completed prior to a milestone review for programs that may affect the quality of the human environment. The Component Acquisition Executive (CAE) is the final approval authority for system-related documentation pertaining to NEPA and environmental Executive Orders.

Documenting these potential environmental impacts can take three different forms:

- **Categorical Exclusion (CATEX):** A document that indicates that neither an Environmental Impact Statement (EIS) nor an Environmental Assessment (EA) is required.
- **Environmental Assessment (EA):** Considers any elements of the environment that might be potentially impacted by the acquisition program. Typically, the EA is prepared in much the same way as an Environmental Impact Statement (EIS), but is much shorter (often 25-50 pages) in length. Generally an EA is required if the PM cannot determine the extent of the program's impact on the environment.
- **Environmental Impact Statement (EIS):** If significant environmental impacts are identified, an EIS is drawn up to document the scope, cost, and potential damage of these impacts. This is typically an extensive document of at least a couple hundred pages. It includes a Notice of Intent that alerts the public to the fact that the Government is contemplating an action that could impact the environment.

These documents are generally prepared by outside contractors with expertise in environmental issues.

EO 13693 (Greening the Government)

Starting in 1998, the last four Presidents have issued environmental policies via Executive Orders (EOs), that direct DoD and all Government agencies to conduct their missions in an environmentally friendly manner. This is sometimes referred to as "Greening the Government".

Executive Orders 13423 and 13514, implemented elements of the major environmental laws and apply to all acquisition programs. These EOs direct the DoD and other Government agencies to use environmentally preferable products and services and implement cost-effective procurement preference programs favoring the purchase of these products and services.

In March 2015, the President issued EO 13693, Planning for Federal Sustainability in the Next Decade. Although this new EO revoked EOs 13423 and 13514, it expanded on the topics covered in the previous EOs and refined the required goals and objectives for government agencies.

Lesson Summary

Programming Funds

Learning Objectives

The following learning objectives are covered in this lesson:

- Identify the basic flow of the financial management process, to include cost analysis, the Planning, Programming, Budgeting and Execution (PPBE) process, Congressional enactment, and program execution.
- Relate the following building blocks to the PPBE process: Future Years Defense Program (FYDP); Major Force Program (MFP); and Program Element (PE).
- Identify the key events in the programming phase, including the preparation, review and decision process associated with the two primary documents of the phase: Program Objectives Memorandum (POMs) and Resource Management Decision (RMD).
- Given programming and budgeting documents, relate the applicable funding policies to each of the five DoD appropriation categories of greatest interest to acquisition programs.
- Identify two exceptions to the full funding policy.
- Identify the concept of escalation in submitting program and budget documents.

Financial Management Process

The financial management process for defense systems acquisition operates as follows:

- It begins with the operational user's capability need, first documented in the Initial Capabilities Document (lCD) and later in the Capability Development Document (CDD) and Capability Production Document (CPD).
- Following lCD approval, an Analysis of Alternatives (AoA) is conducted, Cost as an Independent Variable (CAIV) trade-offs are made, and a program cost estimate is prepared to project resource requirements.
- Cost, schedule and performance targets are identified in the Acquisition Program Baseline.
- The PPBE process is then used to translate plans and programs into a budget that the President submits to Congress.
- Congress in turn authorizes programs and appropriates funds.
- Finally, budget authority is allocated through a series of steps to the services and defense agencies, enabling them to execute their missions.

PPBE Process

The PPBE process is a calendar-driven process that helps DoD determine how to allocate resources. It consists of the following:

- **Planning phase:** Planning examines national defense from a broad perspective in terms oflong-term strategies, policies, and objectives. The end product of planning is the Defense Planning Guidance (DPG), which provides input for the Programming phase.
- **Programming phase:** Programming translates planning decisions into time-phased resource requirements. Through programming, military departments and defense agencies allocate resources to support their roles and missions for the next five years in terms of money and next eight years in terms of manpower. They submit their requirements in a Program Objectives Memorandum (POM), which is amended and approved by OSD in Resource Management Decisions (RMDs).In turn, programming decisions provide input during the concurrent Budgeting phase.
- **Budgeting phase:** This phase is conducted concurrently with the review of the POMs from the Programming Phase. Budgeting translates programming decisions into detailed resource requirements for the next fiscal year. Each Military Department and Defense Agency produces a Budget Estimate Submission (BES) derived from the first year of their POM. When approved by the DEPSECDEF via RMDs, these ultimately become the DoD portion of the President's Budget.
- **Execution Review:** The final activity of the PPBE process is the Execution review, which is accomplished concurrently with the Program and Budget Reviews. The purpose of the Program Review is to prioritize the programs which best meet military strategy needs; the purpose of the Budget Review is to decide how much to spend on each of these programs; and the purpose of the Execution Review is to assess what is received for the money spent (i.e., actual output versus planned performance). Performance metrics are developed and used to assess actual output against planned performance. These metrics are used to adjust resources to achieve goals.

Note: PPBE is an internal DoD process, but guidance from Congress in the form of ongoing Congressional actions, e.g., passing an Appropriations Act that impacts the next PPBE cycle or directed program terminations or program enhancements may impact the overall PPBE process.

Programming Phase Products

The most important products of the Programming phase are the Program Objectives Memoranda (POMs) and the Resource Management Decisions (RMDs):

- **Program Objectives Memoranda (POMs):** Each year, the military departments and defense agencies submit a combined POM and BES to OSD. The POM proposes a five year allocation of resources to satisfy the Defense Planning Guidance (DPG). These POMs are reviewed by the Joint Staff, who issue the Chairman's Program Assessment (CPA), and by the OSD staff, who recommend program changes through POM Issue Papers. The military departments and agencies can comment on or reclama the issues raised by OSD.
- **Resource Management Decisions (RMDs):** The Deputy Secretary of Defense (DEPSECDEF) makes decisions on the POMs and BESs submitted by the Services and defense agencies, and documents his decisions in RMDs. The RMDs will be reflected in the Defense portion of the President's Budget submission.

Programming and Budgeting Tools

There are several tools that provide data and structure for programming and budgeting.

- **Future Years Defense Program (FYDP):** The FYDP is a single database that summarizes all forces, resources, and equipment associated with programs approved by the Secretary of Defense. In addition to showing past and current funding and manpower levels, it shows funding requirements for the next five years, as well as manpower requirements for the next eight years.
- **Major Force Programs (MFP):** The FYDP breaks data into eleven different major programs that contain the total aggregation of resources necessary to achieve a mission objective, such as General Purpose Forces or Research and Development. Each MFP is divided into program elements.
- **Program Elements (PE):** PEs are the primary units of data in the FYDP, the smallest aggregation of resources controlled by OSD. Represented by an eight to ten digit code, PEs are considered to be the "building blocks" of the programming and budgeting process.

Funding Policies

Funding policies are used to govern the PPBE process, and different policies apply to different appropriation categories:

- **Annual funding policy:** Governs Operations and Maintenance (O&M) and Military Personnel (MILPERS) funds. Annual funding policy requires that we request only the dollars that we need to spend in order to operate, maintain, or pay the forces in a given fiscal year. This generally pertains to routine expenses, for example equipment maintenance and labor costs.
- **Incremental funding policy:** Governs RDT&E funds and requires you to budget only for the research and development effort that is needed during a given fiscal year. Emphasis is on covering only those expenses to be incurred, based on the work expected to be accomplished during that year.
- **Full funding policy:** Governs PROCUREMENT, MILCON, and SCN funds and provides for the procurement of useable end items which must be delivered within a 12- month period after delivery of the first item. Full funding requires us to budget sufficient funds to cover the total cost to deliver a quantity of usable end items, such as aircraft, missiles, ships, or vehicles that can be delivered in a future 12 month delivery period. Piecemeal procurement of systems is not permitted.

Full Funding Policy Exceptions

There are two exceptions to the full funding policy:

- **Advance procurement** funds are set aside to buy certain components, material, or effort before an end item is procured in order to avoid a serious break of continuity. For example, advanced procurement might be used to obtain a long- lead time item to prevent a break in production, or to maintain critical skills that might otherwise be lost between early and later stages of a manufacturing process. Advance procurement funds are budgeted as a separate line item, usually one fiscal year in advance of the funds budgeted for the related end item.

- **Multiyear procurement** can be used to acquire multiple years' worth of equipment with a single contract in order to reduce cost and maintain stability in the acquisition process. The Government makes a commitment to the contractor to procure a specific quantity of a weapon system over several years, thus giving the contractor incentive to realize savings, particularly through economic order quantity (EOQ) purchases and investment in productivity enhancements. Congress must approve all multiyear procurements.

Escalation

Since Program and Budget requests are projections into the future, they must take into consideration possible market forces that will influence the economy. Escalation allows us to make predictions about expected inflation and outlay rates for each year of the program. There are two types of dollars referred to when we talk about escalation:

- Constant, or Base Year, dollars are tied to a specific year with no inflation across the life of a program. Constant dollars are usually used for cost estimates because it makes it easy to make changes across the year without considering the impact on the cost of money over time.
- Current, or Then Year, dollars include inflation and outlay rates to account for when the money is actually supposed to be outlayed from the Treasury. This type of dollars is used for program and budget documents and is found in the FYDP.

Escalation Indices

There are two types of indices used when we apply escalation:

- Compound, or Raw, indices relate price levels for each year to a baseline year. This is annual compounding of inflation, similar to the way interest is received on a savings account. The compound indices are used to convert dollars in one Base Year to dollars in another Base Year.
- Composite, or Weighted, indices factor in the historical outlay pattern of the appropriation and inflation rates associated with the fiscal years when cash flows out of the US Treasury. Based on this rate of outlay, appropriation expenses can be loosely predicted to provide a more accurate budgeting picture. The composite indices are used to convert Base Year dollars to Then Year dollars.

DoD publishes escalation indices at least twice a year for the services and defense agencies to use in preparing PPBE input. Program and budget documentation is initially prepared in constant or Base Year dollars and then escalated into current or Then Year dollars so that the funding requested in those future years will be sufficient to pay for expenses that will be incurred in those years.

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Lesson Summary

RFP Preparations (Part I)

Learning Objectives

The following learning objectives are covered in this unit:

- Identify the complementary roles and responsibilities of the Contracting Officer and the Program Manager in their partnership throughout the acquisition process.
- Identify the role of various Integrated Product Team (IPT) members in conducting market research and developing the solicitation.
- Recognize the purpose and formats of the Integrated Program Management Report (IPMR).
- Select appropriate contract type based upon program risk.
- Identify current socioeconomic programs and determine their contractual consequences.

Program Manager and Contracting Officer Roles

The Program Manager is ultimately responsible for an acquisition program, but the PM must rely on the Contracting Officer to enter into the business agreements needed to carry out that program. The Contracting Officer serves as business advisor and is responsible for the following actions:

- Prepare and release solicitations (e.g., Request for Proposals (RFPs).
- Communicate with potential offerors and conduct negotiations with contractors.
- Ensure consistency with the Federal Acquisition Regulation (FAR), the Defense Federal Acquisition Regulation Supplement (DFARS), and all other regulations, policies and laws.
- Prepare, award, and administer contracts and any modifications to the contracts, and terminate contracts.

Market Research

The government must conduct appropriate market research before soliciting offers from potential contractors. Various IPT members can participate. For example, technical Integrated Product Team (IPT) members can evaluate existing commercial products and non-developmental items (NDI), which must be considered as a primary source of supply. Cost analysts can provide input on proper contract pricing information. The extent of market research will vary depending upon the value, complexity, and urgency of the procurement.

Socioeconomic Programs

The government has implemented a series of targeted socioeconomic programs to help small and disadvantaged businesses related to historical economic disadvantage and underutilization of minority and women-owned small businesses. These include the following:

- **Small Business**: A business which is independently owned and operated, but not dominant its field, and meets the size requirements specified in Federal Acquisition Regulation (FAR) 19.102. (The Small Business Administration (SBA) establishes size standards on an industry-by-industry basis).
- **Small Disadvantaged Business (SDB)**: A small business, which is at least 51% owned and managed by a person or persons who are socially and economically disadvantaged.
- **8(a) Business**: A SDB which has been approved by the SBA for participation in the 8(a) program. Majority owners must be socially disadvantaged individuals, that is, members of a group that has been subject to racial or ethnic prejudice or cultural bias.
- **Economically Disadvantaged Women-Owned Small Business (EDWOSB)**: A small business that is 51% owned by one or more women who are economically disadvantaged.
- **Service-Disabled Veteran-Owned Small Business (SDVOSB)**: A small business that is owned by a veteran who has incurred a service-related disability.
- **Historically Underutilized Business Zone (HUB Zone) Business**: A small business that operates in a HUB Zone and 35% of its employees reside in zone.

Contracts greater than $3,000 but less than or equal to $150,000 are set-aside exclusively for small businesses if at least two responsible small businesses can be expected to submit offers.

Contract Types

The type of contract determines how cost risk is shared between the government and the contractor, and it can provide effective contractor incentives. The tradeoffs associated with contract type must be weighed carefully before a solicitation is released.

Cost-Reimbursement Contracts

In cost-reimbursement contracts, the government pays all allowable, allocable, and reasonable costs incurred on the contract, while the contractor promises to put forth their best effort.

Fixed-Price Contracts

In fixed-price contracts, the contractor promises to deliver on time and to meet contract specifications for a negotiated price. As we move from cost-reimbursement towards fixed-price contracts, the contractor assumes more of the cost risk and the government assumes less. On the other hand, cost-reimbursement contracts require more government monitoring and administration than fixed-price contracts.

Within these two broad categories of contract type are a number of common variations:

Firm Fixed-Price (FFP):

- Negotiated fixed-price is not subject to any adjustment, regardless of the cost.
- Contractor bears all cost risk; has maximum incentive to control cost.
- Minimum administrative burden for contractor and government.
- Most appropriate when the requirement is well-defined and a fair and reasonable price can be established at the outset.

Fixed-Price Incentive (FPI):

- Parties negotiate a target cost, target profit, share ratio and ceiling price prior to contract award.
- Government pays all allowable, allocable, and reasonable costs up to the ceiling price.
- Based on the contractor's cost overrun or underrun and the share ratio, the target profit is adjusted upward or downward upon contract completion.
- Government will not pay beyond the negotiated ceiling price regardless of cost incurred.
- Contractor must deliver on time and meet all specifications.

Cost-Plus-Fixed-Fee (CPFF):

- Contractor is reimbursed for all allowable, allocable and reasonable costs incurred plus the negotiated fee.
- Fee is negotiated prior to contract award and is not adjusted regardless of cost incurred.
- Contractor has minimum incentive to control costs.

Cost-Plus-Incentive-Fee (CPIF):

- Parties negotiate a target cost, target fee, share ratio, maximum fee and minimum fee prior to contract award.
- Contractor agrees to provide "best effort" to deliver the product or service.
- Based on contractor's cost overrun or underrun and the share ratio, the target fee is adjusted upward or downward upon contract completion.
- Based on the will not be paid fee exceeding the negotiated maximum fee but will be paid all allowable, allocable and reasonable costs
- Contractor is assured the minimum fee regardless of the extent of the cost overrun and is paid for all allowable, allocable and reasonable costs.

Cost-Plus-Award-Fee (CPAF):

- Consists of a base fee ranging from 0 to 3% and an award fee pool allocated to award fee periods.
- Each award fee period emphasizes different elements on which the contractor should focus
- Government makes subjective, unilateral decision on how much fee to award for each award fee period.
- Requires government to make periodic performance evaluations of the contractor.
- Highly administratively burdensome to the government.
- Award fee may also be used as an add-on-incentive with other types of contracts.

Acquisition Regulations and Policy

The PM is responsible for managing the program in accordance with the DoD 5000 series of acquisition policy, while the Contracting Officer is responsible for contract management in accordance with the FAR. Thus, the two must work closely together and understand their respective roles throughout the life of the program.

Integrated Program Management Report

Earned value management reports are available to help the PM track the contractor's cost, schedule, and performance against a Performance Measurement Baseline.

The **Integrated Program Management Report (IPMR):**

- Required for all cost or incentive contracts greater than or equal to $20 million. For contracts below $20 million, the decision to use EVM is based on a risk assessment.
- Contains seven formats of information.
    - The government requires EVM System (EVMS) reporting data (Integrated Program Management Report (IPMR) – all 7 Formats) for cost and incentive contracts greater than or equal to $50 million.
    - EVMS reporting data in the form of IPMR Formats 1, 5, 6 and 7 are required for cost and incentive contracts greater than or equal to $20 million but less than $50 million (Formats 2, 3, and 4 are included at the optional discretion of the Program Manager).
    - In some circumstances, the Program Manager may require EVMS data for cost or incentive contracts below $20 million. Although there is no requirement, a recommended optional application would include only Formats 1, 5 and 7. In some instances, Format 6 may be recommended as well.
    - EVM reports are discouraged on Firm-Fixed Price and Time and Material contracts.

The IPMR is useful in providing objective data about the status of contractor performance. It identifies current problems, emerging problems, and their potential cost and schedule impact. The Program Manager should determine the formats to be reported based on such considerations as value of the contract, complexity of the effort, and past performance of the contractor.

Lesson Summary

RFP Preparations (Part II)

Learning Objectives

The following learning objectives are covered in this unit:

- Identify the aspects of the Joint Capabilities Integration and Development System (JCIDS) as it applies to acquisition of Information Technology (e.g., interoperability, architecture, and reuse).
- Identify the policy and concepts involved in the acquisition of data rights.
- Identify key laws and software acquisition management policies that are required for the acquisition of a DoD automated information system.
- Identify "best practices" that may be appropriate for the acquisition of software-intensive systems.
- Identify key discriminators for selecting the most capable software developer.
- Identify DoD policy regarding Basic Quality Systems and the role of ISO 9001.

Quality Systems

ISO 9001

As a result of acquisition reform in 1994, the ISO 9001 series of International Quality Standards has been implemented by many contractors, shifting the focus to preventing problems in quality rather than repairing them after they have occurred.

ISO 9000 deals with the fundamentals of quality management systems, including the eight management principles on which the family of standards is based (customer focus; leadership; involvement of people; process approach; systems approach to management; continual improvement; factual approach to decision making; and mutually beneficial supplier relationships). ISO 9001 deals with the requirements that organizations wishing to meet the standard have to fulfill. Third party certification bodies provide independent confirmation the organizations meet the requirements of ISO 9001.

Contractor's Choice

However, DoD guidance allows contractors to use the quality assurance process of their choice, as long as it meets program objectives and does the following;

- Establishes capable processes
- Continuously improves processes
- Monitors and controls critical processes and product variation
- Has feedback mechanisms in place to assess field product performance
- Implements effective root cause analysis and corrective action systems

Although the Government cannot require that a contractor be ISO 9001 compliant, a contractor can be asked to provide an equivalent quality assurance system in place, with similar characteristics to those listed above. The intent of the ISO 9000 series of standards, and other quality standards is to require companies to manage quality as a fundamental focus of their business.

Automated Information System Risk Reduction

There are special risks associated with the acquisition of an automated information system. As a result, DoD guidance states that it is preferable for software developers too:

- Have a successful past performance record, experience in the domain or product line, a mature software development process, and evidence of adequate training in software development tools and environments.
- Develop system architectures that support open system concepts, exploit existing commercial products, and provide for incremental improvements based on modular, reusable and extensible software.
- Identify and exploit software reuse opportunities before beginning new development initiatives.
- Select a programming language based on overall life-cycle costs, risks, and interoperability potential.
- Use DoD standard data.
- Use a software measurement process to plan and track the software development program.

Software Developer Capability Evaluation

The CMMI models can be used throughout the acquisition lifecycle by industry as well as Government. Although process areas depict the characteristics of an organization committed to process improvement, you must interpret the process areas using an in-depth knowledge of CMMI, your organization, the business environment, and the specific circumstances involved (**STUDENT NOTE**: Refer to the CMMI-DEV document linked to this lesson for greater detail on CMMI-DEV model).

To interpret practices, it is important to consider the overall context in which these practices are used and to determine how well the practices satisfy the goals of a process area in that context. CMMI models do not prescribe nor imply processes that are right for any organization or project. Instead, CMMI describes minimal criteria necessary to plan and implement processes selected by the organization for improvement based on business objectives.

CMMI practices purposely use nonspecific phrases such as "relevant stakeholders," "as appropriate," and "as necessary" to accommodate the needs of different organizations and projects. The specific needs of a project can also differ at various points in its life.

When selecting a contractor to develop software, the Government can evaluate their capability using a Standard Capability Maturity Model Integrated (CMMI) Appraisal Method for Process Improvement (SCAMPI). Based on the CMMI model used, a SCAMPI evaluation enables a sponsor to:

- Gain insight into an organization's capability by identifying the strengths and weaknesses of its current processes relative to appraisal reference model(s)
- Focus on improvements (correct weaknesses that generate business risks) that are most beneficial to the organizations given its current level of process implementation
- Identify risks relative to achieving capability or maturity targets

The Government can also use the SCAMPI to assess the maturity of their own internal software acquisition and development processes.

Using CMMI Appraisals

Many organizations find value in measuring their progress by conducting an appraisal and earning a maturity level rating or a capability level achievement profile. These types of appraisals are typically conducted for one or more of the following reasons:

- To determine how well the organization's processes compare to CMMI best practices and identify areas where improvement can be made
- To inform external customers and suppliers about how well the organization's processes compare to CMMI best practices
- To meet the contractual requirements of one or more customers

Appraisals of organizations using a CMMI model must conform to the requirements defined in the Appraisals Requirements for CMMI (ARC) document. Appraisals focus on identifying improvement opportunities and comparing the organization's processes to CMMI best practices.

Appraisal teams use a CMMI model and ARC-conformant appraisal method to guide their evaluation of the organization and their reporting of conclusions. The appraisal results are used (e.g., by a process group) to plan improvements for the organization.

Software Acquisition Best Practices

DoD has identified a number of key best practices to follow in the acquisition of software. They include:

- Identify and manage risk continuously throughout the life of the system.
- Estimate cost and schedule empirically.
- Use metrics to monitor risk, identify problems, and base decisions.
- Track earned value.
- Establish quality targets and track defects against those targets.
- Treat people as your most important resource.
- Implement a sound configuration management process.

- Manage and trace requirements to the lowest level.
- Use system-based software design to document and evaluate the process.
- Ensure data and database interoperability.
- Define and control all internal and external interfaces.
- Design twice, code once.
- Address the risks of reusing existing software, whether commercial or non-developmental items.
- Inspect requirements and design, subject to configuration management products to formal inspection.
- Conduct continuous testing based on plans, pass-fail criteria, and traceable procedures.
- Compile and smoke test frequently.

Interoperability Requirements

In today's military environment, systems must be interoperable in order to be effective; that is, they must be able to exchange data. To ensure interoperability, all systems acquired by DoD that will produce, use, and exchange information must be consistent with the DoD Information Technology Standards Registry (DISR).

The DISR provides a common set of mandatory standards for information processing, transfer, modeling, interfaces, and systems security. The interoperability requirements are captured in the program's Net-Ready KPP. In addition to compliance with DISR, all systems, regardless of ACAT, must undergo a two-step oversight process to ensure all interoperability capabilities are identified and met.

Interoperability Capability Certification

This process, based on the capability needs identified by the user in the ICD, and CDD/CPD, ensures that we consider interoperability from the very beginning. Before the capabilities can be approved for a system, the Joint Staff must certify that **interoperability capabilities** are identified and consistent with joint policy, architectural integrity, and interoperability standards.

Interoperability Certification

This process is used to demonstrate, based on actual performance tests conducted in the field, that interoperability capabilities have been met. After completion of this testing, the Joint interoperability Test Command (JITC) issues a Letter of Certification to document that the required level of **interoperability performance** was achieved.

Data Rights – Basic Principles

As outline in the program's Intellectual Property (IP) Strategy, the Government should acquire the appropriate rights to data, software, intellectual property, and other documentation to facilitate competition over the life of the system. The key to success is ensuring requirements and strategies are identified and acted on early in the acquisition to avoid unexpected costs to procure, reformat, or deliver data. Important basic principles are summarized on the following page:

- Data deliverables or data items are delivered in response to contract requirements for data that has pre-determined content and format. Generally, there is no automatic delivery of data, nor does the Government have any automatic rights to technical data.
- To receive data or have access to data the Government must explicitly request it in the contract using a Contract Data Requirements List (CDRL).
- In general, the contractor continues to own the actual data or intellectual property; government owns the deliverable and has license rights that govern how the data may used.

Data rights fall under the following categories:

Unlimited rights

If the Government has funded the entire development of an item, then it is entitled to unlimited rights to use, duplicate, or disclose technical data for any purpose.

Limited rights

If a contractor has developed an item entirely at its own expense, then the government is only entitled to limited rights, within the Government itself, and normally cannot release the data to other parties outside the Government.

Restricted Rights

These rights only apply to noncommercial computer software, and are similar to limited rights.
An example would be restricting usage of a computer program to only one computer at a time.

Government Purpose Rights

When technical data is developed with mixed funding (part contractor and part government), government purpose rights allow the Government to use the technical data for Government purposes as described in limited rights and for other purposes such as competition, but not for commercial applications.
Government purpose rights are automatically effective for five years and revert to Unlimited Rights upon expiration of the five-year period.

Lesson Summary

Source Selection

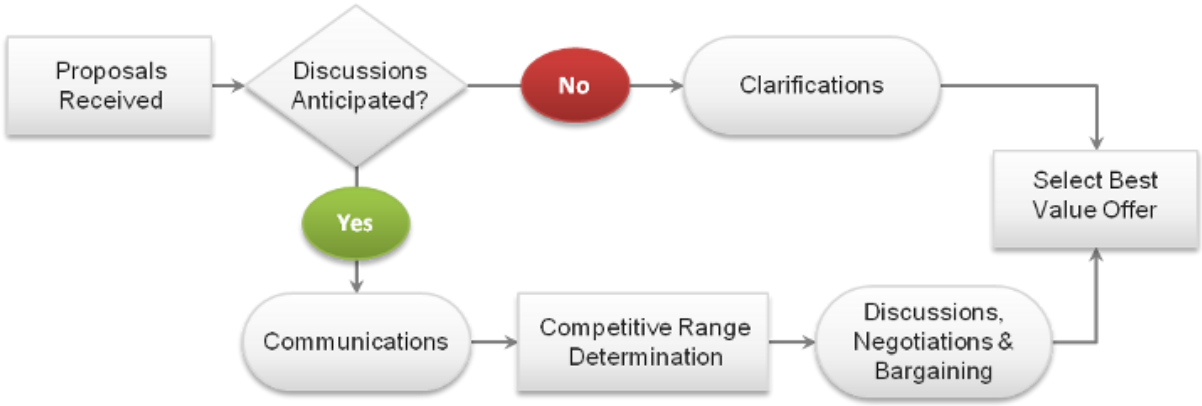
Learning Objectives

The following learning objectives are covered in this unit:

- Identify the complementary roles and responsibilities of the Contracting Officer and the Program Manager in their partnership throughout the acquisition process.
- Differentiate among the various types of interaction between the Government and contractors, e.g., discussions, clarifications, deficiencies, communications, and exchanges.
- Identify the role and responsibility of the participants in fact-finding and negotiations.
- Identify how to prepare for and conduct a fact-finding activity.
- Identify how to prepare for and support a negotiation.
- Recognize the importance of contractor finance principles to the defense acquisition process.
- Identify how the balance sheet and income statement portray the operating characteristics and health of a business.
- Differentiate generally between direct cost and indirect cost.
- Identify how indirect costs are allocated to a contract.
- Identify the five bases for cost allowability.
- Recognize the purpose and application of forward pricing rates to government contracts.
- Explain how corporations use their organization to implement their business strategies.
- Recognize how company organizations can create a competitive advantage.
- Recognize different typical company organizational models used between small and large businesses.

Source Selection Information Exchanges

Throughout the source selection process, IPT members must take care to protect the interests of both the Government and the contractors competing for the work. Government personnel must be careful not to disclose procurement sensitive or proprietary information to unauthorized personnel and to avoid any exchange that would give an advantage to any one offeror.



Fact-Finding Information Exchanges

After proposals are received and initially evaluated against the source selection factors and subfactors by the Source Selection Evaluation Board, the Contracting Officer determines whether or not to hold discussions with the offerors in order to achieve the best value to the government. Only the most highly rated proposals are included in the "competitive range." Throughout the process, the Contracting Officer conducts fact-finding activities to gain a complete understanding of the proposals and identify specific areas of concern which include ambiguity, weaknesses, or deficiencies. There are several types of information exchanges involved in fact-finding.

Clarification

If no discussions are anticipated, then the Government may request comments from the offeror on any negative past performance information to which they have not seen or been allowed to comment on previously. These are called clarifications and are also used to clarify minor clerical errors.

Communication

In order to establish the competitive range of the most highly rated proposals the Contracting Officer may have exchanges known as communications. Communications can be used to resolve uncertainties about specific proposals, to correct minor clerical errors, and to explain any negative past performance information prior to establishing the competitive range.

Discussion, Negotiation, Bargaining

Negotiations

Negotiations are exchanges, in either a competitive or sole source environment, between the government and offerors. The intent of negotiations is to allow offerors to revise their proposals.

Bargaining

Negotiations may include bargaining. Bargaining includes the use of persuasion, the potential alteration of assumptions and positions, give-and-take, and may apply to price, schedule, technical requirements, contract type, or other terms of a proposed contract.

Discussion

When negotiations are conducted in a competitive environment, they take place after establishment of the competitive range and are called discussions. Discussions are tailored to each offeror's proposal and are conducted by the contracting officer with each offeror in the competitive range. The purpose is to indicate or discuss significant weaknesses, deficiencies, and other aspects of the offeror's proposal in order to allow the contractor to make changes to their proposal. These changes to the proposal may enhance the offeror's potential for award. The primary objective of discussions is to maximize the government's ability to obtain best value based on the capability need and source selection evaluation factors.

Communication and negotiations between the government and the contractor must always go through the Contracting Officer

Allowable Costs

During the source selection process, IPT members may be called upon to help evaluate price and cost-related factors. This information helps ensure that the contractor selected has the financial means necessary to perform the work. If a firm already has an existing, forward pricing rate agreement, their contract rates don't need to be evaluated for later contracts. However, the costs included in a contract must be evaluated to determine whether they are allowable.

For a cost to be **allowable**, it must meet **five** criteria. The cost must:

- Be reasonable, that is, the cost does not exceed the cost that a prudent business person would incur in a competitive environment for a similar item.
- Be allocable to the contract, that is, meet any one of the following conditions:
  - The cost is incurred specifically for the contract;
  - The cost is beneficial to both the contract and to other work, and it can be distributed between the two in reasonable proportion; **or**
  - The cost is necessary to the overall operation of the business although a direct relationship to a particular contract cannot be shown.
- Comply with applicable Government Cost Accounting Standards (CAS) and Generally Accepted Accounting Principles (GAAP). These are rules normally used for estimating and reporting costs.
- Be consistent with the terms of the contract. The Government and the contractor can agree that certain costs will be considered unallowable.

- Be consistent with the cost principles identified in the Federal Acquisition Regulation (FAR), which designate certain costs as allowable, partially allowable, or unallowable.

Forward Pricing Rate Agreements (FPRA)

Forward pricing rate agreements (FRPA) are written agreements negotiated between a contractor and the Government to make certain rates available during a specified period for use in pricing contracts or modifications. These rates represent reasonable projections of specific costs that are not easily estimated for, identified with, or generated by a specific contract, contract end item, or task. These projections may include rates for such things as labor, indirect costs, material obsolescence and usage, spare parts provisioning, and material handling. They provide consistency in proposal pricing and save time.

- **Purpose**–An FPRA is used to ensure a fair and reasonable price earned by a contractor and to protect a government agency from being charged unfairly. The contractor estimates these rates based on reasonable standards. The contracting government agency must approve them before the agreement is signed.

- **Process**–Typically, forward pricing rates are estimated by using a percentage or ratio. The percentage or ratio is based upon unforeseen differentials in prices. When the bill is issued, the costs are multiplied by this percentage or ratio. The rate protects the contractors by allowing an extra amount above and beyond the estimated quoted prices. The rate represents costs projected for material and labor costs, for example.

- **Guidelines**–A contractor should submit an FPRA proposal each year. These agreements should also state what time period the rate is good for. The rate should be fair and be used only for labor, indirect costs, material and other items that are not easy to estimate.

Direct and Indirect Costs

Costs incurred by a contractor can be classified as direct or indirect.

- A **direct cost** is a cost incurred by the contractor due to a single contract. Direct costs are often divided into direct material and direct labor costs. An example of a direct cost is the cost of a component purchased exclusively for use on a Government contract.

- An **indirect cost** is a cost incurred by the contractor that cannot be attributed solely to a single contract. Indirect costs include support costs for continued operations. There are two categories of indirect costs: overhead and general & administrative.

- **Overhead costs** support a specific part or function of the company but not the whole company. An example of an overhead cost is the cost of factory maintenance that can be shared proportionally between specific manufacturing jobs.

- **General and Administrative (G&A) costs** are required to support operation of the entire company. An example of a G&A cost is the salary of the chief executive officer.

Financial Statements

Financial statements can help the Government assess the financial health of a company. Two key financial statements are the:

- **Balance Sheet** shows in monetary terms a company's assets (things of value owned by the firm), liabilities (claims against those assets) and owners' equity, at a particular point in time.
- **Income Statement** shows a company's revenue and expenses incurred over a period of time, such as a fiscal year.

Financial Indicators

Two helpful indicators of a company's financial condition are the profitability ratios of return on sales, or ROS, and return on total assets, or ROA:

- **Return on Sales (ROS):** Also known as profit margin, ROS is calculated by dividing net income for an accounting period by revenue. For example, if net income was $15,000 and sales were $300,000, then ROS would be 15,000/300,000 or 5%.
- **Return on Assets (ROA):** ROA measures the efficiency of the firm's investment in assets and their ability to generate revenue. It is calculated by dividing net income for an accounting period by the total dollar value of the assets shown on the balance sheet at the end of the year. For example, if net income was $6,000 and total asset value at the end of the year was $150,000, ROA would equal 6,000/150,000 or 4%.

Both ROA and ROS should be used carefully. Both calculations provide an indicator of a firm's financial health, but variations may be due to unusual accounting events. If a firm has an unusually low ROA or ROS compared with the overall industry, it is important to find out why.

Business Acumen

Organizational Structure

A company's organizational structure facilitates the implementation of its strategy. The company should be organized so that its efforts and resources are focused on implementing and achieving its strategic goals. A company that is organized to remain focused on its mission and with the built-in flexibility to respond to change is going to have a competitive advantage over companies with less effective organizational structures.

Types of Organizational Structures

- **Functional structure** classifies people according to the function they perform in the organization and may include positions such as President, Sales Department, Customer Service Department, etc.
- **Divisional structure** is based on different divisions within an organization, such as different product lines, different markets, or different geographical locations.
- **Matrix structure** is a combination of the functional and divisional structure. This creates an efficient organizational structure; however, it is the most complex because often there is blurring of the lines of authority.

Company Size and Organizational Structure

- **Smaller companies** often concentrate functions in staff organizations to support all business areas or product lines, or outsource core functions such as human resources, accounting, or legal.
- **Larger companies** often decentralize staff functions, dedicating them to each business or product organization.

Version 1.0 (11 July 2014)

Lesson Summary

Technical Risk Management

Learning Objectives

The following learning objectives are covered in this lesson:

- Identify the role of systems engineering in balancing cost, schedule and performance throughout the lifecycle.
- Use Technical Performance Measures to track progress in program risk areas during systems development.
- Identify the role of modeling and simulation as a tool in the systems engineering process.
- Recognize the importance of modeling and simulation in the defense acquisition process.
- Identify the role of the WBS in the systems engineering process.
- Identify how T&E supports the systems engineering process.

Systems Engineering Process

Systems engineering is a problem-solving process that translates capability needs into designs to provide a new or improved capability. This process must take into consideration such factors as producibility, supportability, testability and interoperability to achieve a well-balanced design. Applied within the Integrated Product and Process Development (IPPD) management process, systems engineering brings multiple disciplines together to determine the optimal solution to satisfy capability needs. It is an iterative process throughout a system's development that evolves through a series of steps, from stakeholder requirements definition through architecture design to verification, validation and then transition of the developed system to the User.

The systems engineering process is used to manage the technical risk inherent in development and production of a system. While technical risk has a direct impact on the performance of a system, it also affects program cost and schedule. A number of tools are available to help mitigate technical risk, including modeling and simulation, work breakdown structure, and technical performance measurement.

Modeling and Simulation

Modeling and simulation is an essential part of Simulation Based Acquisition (SBA). SBA involves integrating modeling and simulation across many functional disciplines throughout the acquisition life cycle. Thus, modeling and simulation can be used to support capability needs definition, concept refinement, system design, manufacturing, and testing.

Modeling and simulation offer a number of advantages. Virtual prototypes and simulations provide a common vision of a system, show the complex interactions among parts of a design, and identify the potential effects of alternative approaches without physically changing a system. They allow designers,

logisticians and manufacturers to collaborate on the same design using a common platform or shared database. Through modeling and simulation, IPT members can better understand the relationships among components and evaluate alternatives in a virtual environment. As a result, modeling and simulation can save time and money, improve the quality of hardware and software, produce integrated product designs, and help make better program decisions.

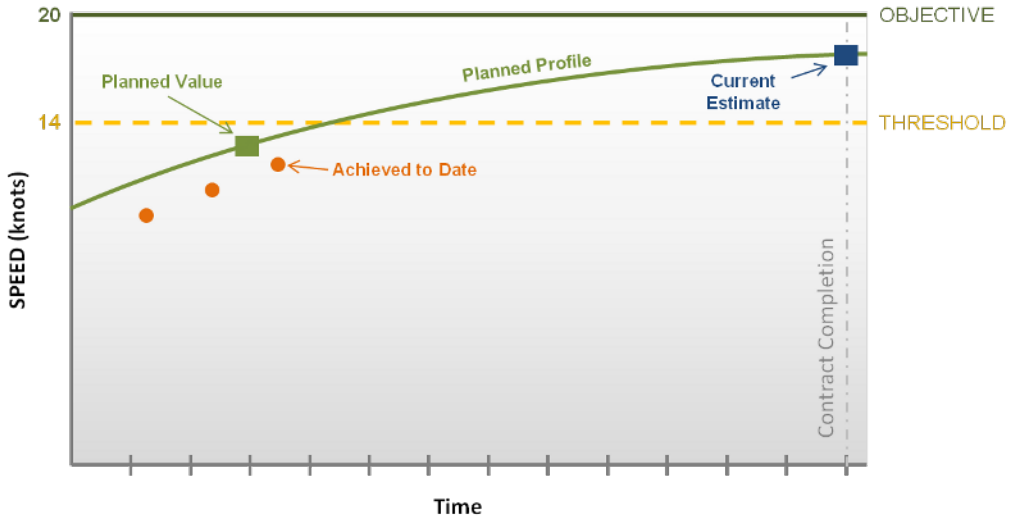
Work Breakdown Structure

A work breakdown structure (WBS) can be used to support a wide range of technical, business, and management functions. The WBS displays and defines the product to be developed, breaking down the overall system into its component parts. For technical management, it helps to identify and assess high-risk elements, establish key interface control requirements, evaluate Engineering Change Proposals (ECPs), and determine the number and type of technical reviews and audits required. The WBS also is used to develop the Statement of Work (SOW) and determine the contract line items (CLINs) that specify contract deliverables.

One of the outputs of the systems engineering process is a draft physical architecture, which serves as the basis for the "product" part of the WBS. In a typical WBS, the products are displayed vertically on the left hand side, while the processes that support those products are displayed horizontally on the right.

Technical Performance Measures

Technical Performance Measures (TPMs) reduce technical risk by tracking certain selected performance parameters over time to identify potential performance problems during system development. TPMs are used to monitor the progress of the most critical, high-risk technical areas. For example, speed and weight might be tracked as TPMs in the development of a new land combat vehicle. TPMs compare actual values against expected values over time to identify problems before they become too difficult or costly to solve.



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Lesson Summary

Designing for Supportability/Trade-Off Analyses

Learning Objectives

The following learning objectives are covered in this unit:

- Identify the role of life cycle product support and systems engineering in balancing cost schedule, and performance throughout the life cycle.
- Identify the key policy provisions that relate to how life cycle product support and systems engineering are performed in the Department of Defense.
- Apply life cycle product support and systems engineering efforts through the Designing for Supportability approach to determine a design solution to meet an operational need that demonstrates the balancing of Affordability objectives and technical activities.
- Identify key acquisition best practices, including commercial practices that impact the relationship between Government and industry.
- Identify life cycle product support resource requirements and understand why it is important to influence system design for supportability.
- Identify Product Support Analyses (PSA) tools/best practices/techniques available in the systems engineering process to achieve the principal supportability goals.
- Relate design, operational and supportability characteristics to systems readiness objectives.
- Identify the relationship of Reliability, Availability, and Maintainability (RAM) and Supportability to life cycle product support, and its impact on system, subsystem and component performance, operational effectiveness, logistics footprint and life-cycle cost.
- Select appropriate management methods and techniques to achieve Reliability, Availability, and Maintainability (RAM) and Supportability parameters.
- Apply the trade-off study process to evaluate alternatives.
- Apply a selected quantitative tool (e.g., decision matrix) to support a decision.

Supportability

Supportability refers to the inherent design characteristics of reliability and maintainability and the efficacy of the product support package required for operating and maintaining the systems, equipment or component throughout its life cycle

Life cycle product support requirements drive the design and development of reliable, maintainable and affordable systems through the continuous application of the systems engineering methodology.

Supportability directly affects operational readiness as well as operations and maintenance costs. In general, over 65–80% of system costs are incurred after the system is fielded/deployed, and most of those costs are already fixed by the time first milestone approval is obtained. Therefore, we must consider system support **early** and **continuously** throughout a system's development.

Designing for Supportability

Designing for supportability incorporates the principles of systems engineering throughout the system life cycle to design, develop, produce, and sustain operationally reliable, supportable, and effective systems.

Trade-Off Analyses

Trade-off analyses examine alternatives among requirements and designs at the appropriate level of detail to support decision making and lead to a proper balance between performance and cost.

Open Systems

One design approach that promotes supportability is open systems architecture, which enables us to use standard design features and interfaces that are compatible with products from multiple suppliers. This approach uses non-proprietary interfaces and protocols and industrial standards to provide interoperable components and portability. Open systems design facilitates technology insertion and product modification by taking advantage of standardization. It also results in lower life cycle costs, with a greater number of suppliers available to compete to meet our needs.

Reliability, Availability Maintainability, and Supportability

Reliability, Availability Maintainability (RAM) and Supportability are important design and operational characteristics should be addressed early in the acquisition process and throughout the life cycle. The goals of RAM and Supportability are higher operational effectiveness and lower life cycle costs.

Reliability

Reliability is how long an item or system will perform its function before it breaks. It is measured in Mean Time Between Failure (MTBF). Reliability is the probability that a system will perform its function within stated time and performance conditions. Poor reliability will reduce readiness, increase logistics support requirements, increase life cycle costs, and waste manpower. However, redundancy, the use of back-up systems or parts, can increase reliability.

Maintainability

Maintainability is how quickly, easily and cost effectively a system can be returned to operational status after preventative or corrective maintenance is performed. It is measured by Mean Time to Repair (MTTR), or how quickly and easily a system can be fixed. Maintainability is a consequence of the design process, so initial engineering efforts are vital to creating a maintainable product.

Human Systems Integration

One determinant of maintainability is Human Systems Integration (HSI), which has several aspects:

- **Accessibility:** Can the part be easily accessed for repair?
- **Visibility:** How easily can you see the part being worked on?

- **Testability:** How easy is it to test and detect faults?
- **Standardization:** Are parts interchangeable, and can standard tools be used?

The more user-friendly the design, the faster the repair and upkeep can be performed.

Supportability

Supportability is the degree to which a system's design and planned logistics resources support its readiness **needs and wartime utilization. Unlike reliability or maintainability, supportability includes activities and** resources (such as fuel) that are necessary whether the system fails or not. It also includes all resources, such as personnel and technical data that contribute to the overall support cost.

The PM can address the long versus short term issue by designing for the optimal balance between performance (technical and supportability), life-cycle costs, schedule, and process efficiency. The Affordable System Operational Effectiveness (ASOE) concept is important because it is what the user sees in terms of how well the system is able to perform its missions over a sustained period as well as the ability to surge given the user's operating budget. In this concept the emphasis is not only on the system's ability to execute its mission or its reliability and maintainability, but also on the cost effective responsiveness of the supply chain.

- The concept of ASOE is used to address the interplay between system performance, availability (reliability, maintainability, and supportability), process efficiency (system operations, maintenance, and life cycle product support), and system life cycle cost. This overarching perspective provides a context for the "trade space" available to a PM to increase reliability and drive down life cycle costs.

- ASOE is the composite of performance, availability, process efficiency and Life Cycle Cost (LCC). The objectives of ASOE are to influence early design via the combination of the System Design for Operational Effectiveness (SDOE) approach and the Supply Chain Model (SCM) as contributors to LCC. SDOE focuses on the impact of reliability and maintainability design parameters and their role in operational effectiveness and suitability requirements; SCM focuses on the logistics activities that enable effective sustainment.

Availability

Availability is the heart of mission readiness. Obviously, the more reliable and maintainable an item, the greater its availability

The presence of a solid RAM and Supportability ensures system readiness by ensuring Operational Availability (A_O). A_O is measured as a ratio of the time a system is able to be up and running to the total time a system is required (A_O = Uptime/Total Time). When a system is not able to be up and running, its downtime can be attributed to:

- Logistics delays–parts out of stock
- Administrative delays–personnel or paperwork delays
- Corrective maintenance –making repairs
- Preventive maintenance –routine service

Product Support Analysis (PSA)

Because RAM and Supportability are so important, we must evaluate them throughout the design and development process. Supportability analyses are jointly conducted by the Systems Engineering and Life Cycle Logistics communities to address the impact of the design characteristics of reliability and maintainability on

the design and the product support system. The product support package equates to the resources and infrastructure required to support systems in the field. PSA, an iterative and multidisciplinary process, is used as part of the life cycle product support and systems engineering processes to influence design as well as determine the most cost effective way to support the system throughout its life.

A number of tools are available to evaluate supportability, including:

- **Failure modes and effects criticality analysis (FMECA):** Examines each failure to determine and classify its effect on the entire system.
- **Reliability centered maintenance (RCM):** Uses a scheduled maintenance approach to identify failures before they degrade system effectiveness.
- **Level of Repair Analysis:** Level of Repair Analysis LORA is a prescribed procedure for defense logistics planning. LORA is performed to determine the best, most efficient location where an item can be repaired.

Analysis of product support - this portion of the PSA process commences at the system level to affect design and operational concepts; identify gross product support resource requirements of alternative concepts; and to relate design, operational, and supportability characteristics to system readiness objectives and goals.

Trade-Offs

Creating a supportable design that is also producible, testable, and affordable involves making trade-offs among competing features. A decision matrix can be used to systematically compare choices by selecting, weighting and applying criteria.

A decision matrix has eight steps:

1. Identify the items to be compared.
2. Establish evaluation criteria (e.g., reliability, cost, etc.).
3. Assign weight to each criteria based on its relative importance.
4. Establish a quantitative rating scheme (e.g., scale from 1 to 5).
5. Rate each item on each criteria using the established rating scheme.
6. Multiply the rating for each item by the assigned weight for each criteria.
7. Add the totals for each item.
8. Find the highest score which determines the best value.

Choices	Reliability (MTBF) 0.6	Cost ($) 0.3	Maintainability (MTTR) 0.1	Totals
BIT 01 (MTBF = 150; $ = 8K; MTTR = 3 hrs)	1 X 0.6 = **0.6**	3 X 0.3 = **0.9**	1 X 0.1 = **0.1**	**1.6**
BIT 02 (MTBF = 175; $ = 10K; MTTR = 2 hrs)	2 X 0.6 = **1.2**	2 X 0.3 = **0.6**	2 X 0.1 = **0.2**	**2.0**
BIT 03 (MTBF = 250; $ = 11K; MTTR = 1 hrs)	3 X 0.6 = **1.8**	1 X 0.6 = **0.3**	3 X 0.1 = **0.3**	**2.4**

Lesson Summary

Software Design

Objectives

The following learning objectives are covered in this lesson:

- Recognize the relationship between software development activities and the systems engineering process.
- Identify common ways that software-intensive projects have gotten into trouble.
- Given a software-intensive system (such as a telecommunications or guidance system), select an appropriate software development methodology.
- Identify typical software development lifecycle activities and standards.
- Using DoD Practical Software Measurement methodology principles, select appropriate software measures to make sound decisions regarding acquisition of software intensive systems.

System Architecture

The structure or architecture of a defense information system can be viewed in three different ways.

- **Operational Architecture** describes how the system meets the end-user's or warfighter's information needs.
- **Systems Architecture** shows the "physical" structure and information flows.
- **Technical Architecture** describes how hardware and software components interact to satisfy user requirements.

Software Development Considerations

The development and integration of software is a complex and challenging aspect of system acquisition. Some points to consider:

- All new and upgraded command, control, communications, computer, and intelligence (C4I) systems must be in compliance with the DoD Information Technology Standards Registry (DISR).
- Commercial software components that are already DISR-compliant can be used to save time and are usually easier to maintain and upgrade.
- Identifying system requirements is one of the most important aspects of software development.
- Software modification doesn't just affect the software itself: hardware issues also need to be explored to determine the impact of software modifications on the total system.

Sources of Software Problems

Software development can become difficult due to a variety of problems, many of which are within the control of the program manager. Typically, software problems come from the following sources:

- Poor requirements definition
- Lack of user involvement
- Poorly-defined architecture and interfaces
- Overlooking hardware deficiencies
- Failure to establish a functional team of vendors, experts, and end users

Software Development Methods

Tradeoffs must be made when selecting the engineering/development approach to take in acquiring software. For example, we might make a choice between modifying existing software or undertaking a new development. In addition, different methods can be used to develop software:

- The **Waterfall** method is based on a top-down approach. It requires extensive formal documentation, which can be time consuming. This approach is often used late in the life cycle, and it is best used for systems with relatively stable requirements.
- The **Incremental** method requires strong configuration and requirements management. It is best utilized when budget or schedule constraints impact the final product such that additional features could be added later, if needed.
- The **Spiral** model incorporates extensive prototyping to ensure proper risk management. It is best used in situations where the system is unstable and user capability needs are not clear or have not been properly defined.

Software Measurement Techniques

Different measurement techniques are available to track software development progress. These measurement techniques fall into three categories:

- **Process metrics** deal with the maturity and robustness of organizational processes that are used to develop software. They examine qualifies such as process maturity, developer productivity, amount of rework required, and the impact of technology.
- **Quality metrics** are concerned with software product attributes that can impact performance, user satisfaction, supportability, and ease of change. They are used to track attributes such as software integrity, reliability, usability, maintainability, interoperability, and flexibility.
- **Management metrics** compare actual progress against plans. These indicators can suggest trends, detect trouble early, or trigger the need to make adjustments to plans so that they are more realistic. Management metrics deal with questions regarding scheduling, personnel, requirements volatility, cost performance, and individual work unit progress.

Lesson Summary

Commercial and NDI

Learning Objectives

The following learning objectives are covered in this lesson:

- Identify key issues regarding test and evaluation of commercial and non-developmental (NDI) items.
- Identify the role of Early Operational Assessment (EOA) in reducing program risk.
- Recognize key logistics related acquisition policies and their impact (e.g., life-cycle cost, contractor logistics support, commercial and non-developmental items).

Non-Developmental Items and Commercial Items

Non-developmental items (NDI) are previously developed items used exclusively for governmental purposes by federal, state, local, or allied governments. Commercial items are generally used for non-governmental purposes and are offered for sale, lease or license to the general public.

Benefits from Using NDI and Commercial Items

The use of non-developmental items and commercial products is encouraged to reduce life cycle costs associated with having to develop new products or systems. Use of these types of products doesn't completely eliminate testing and supportability issues, but it can drastically cut development costs.

The benefits of using NDI and commercial products include:

- Reduced cycle time
- Reduced/eliminated R&D cost
- Reduced technical, cost and schedule risk
- Availability of product samples for source selection process
- Availability of state-of-the-art technology

Drawbacks from Using NDI and Commercial Items

On the other hand, there can be drawbacks to using NDI and commercial products:

- Difficulty in integrating components
- Long-term logistics support problems
- Lack of engineering and test data

Testing

The amount and type of testing required for an NDI or commercial item depends on how the item will be used, whether any modifications are needed, and the availability of previous test results.

- If the item will be used in the same environment for which it was originally designed, developmental testing is usually not necessary. However, operational testing will be required if the item will be maintained by the Government.
- If the item will be used in a different environment than that for which it was originally designed, some developmental testing may be required to ensure the item meets specifications or make sure the manufacturing process is effective. Operational testing, including early operational assessment (EOA) and operational assessment (OA), will be required to verify effectiveness and suitability.
- If the item will be integrated into a system, developmental testing will be required on a test sample before the item is integrated into the system. Pre-production testing of the complete system, including both hardware and software, may be conducted. Operational testing of the complete system will also be required.
- If the item will be modified, both developmental testing and operational testing will be conducted to insure the modification meets all the requirements.

Modifications

Making government unique modifications to commercial or non-developmental items may invalidate testing and usage data. The more we modify these items, or change the way in which they will be used, the more additional testing we will need to conduct.

Early Operational Assessment

Operational testing and evaluation (OT&E) is the primary means of assessing weapon system performance. One type of OT&E, Early Operational Assessment (EOA), is conducted to forecast and assess potential operational effectiveness and suitability of the weapon system during development. It is used to detect deficiencies that may impact the performance, availability, and supportability of a system. Thus, EOA increases our confidence in the NDI or commercial item, thereby reducing our probability of failure, which in turn reduces risk.

The use of NDI and commercial items raises long-term supportability issues. For example, we could face a situation where the vendor changes the product line or discontinues making replacement parts. In addition, there may be problems with design interface and the interoperability of parts with the overall system. Furthermore, service unique logistics capability needs may be difficult to meet with commercial and NDI products.

Organic or Contractor Logistics Support

When deciding to use commercial or NDI items, we must determine how best to support the system once it is fielded; i.e., whether to use organic support using military personnel or to contract out logistics support.

Both options have their merits and drawbacks, and determining these can be done by taking into account the following circumstances:

- How much modification is required to make the item fully operational? If significant changes are required before the item is used by the military, then government (organic) logistics support might be the best approach.
- How or where will the item be used? If the environment will be hostile or austere, it could affect the contractor's ability to support the item due to safety concerns, and government (organic) logistics support might be the best approach.
- What is the projected service life? For short-term items, contractor logistics support is often more appropriate.
- How stable is the design or configuration? If constantly changing configurations are inevitable, especially due to advances in technology, then contractor logistics support is likely to be the better option.

Version 1.0 (11 July 2014)

Lesson Summary

Role of Manufacturing

Learning Objectives

The following learning objectives are covered in this lesson:

- Recognize the impact of manufacturing on cost, schedule, and performance.
- Recognize the relationship of manufacturing to the systems engineering process.
- Identify the methods and objectives of manufacturing that influence system design.
- Distinguish from among the types of trade-offs that may be required to attain a producible design.

Benefits of a Producible Design

Manufacturing considerations impact the systems engineering process by influencing the design for producibility. This results in a more robust, balanced design that is cheaper and easier to build. A producible design is more stable and leads to a higher quality product that can be introduced more quickly at lower overall cost. Manufacturing a product with high producibility will reduce assembly errors, repair costs, labor time and wasted material. By designing for producibility up front, manufacturing costs, which usually account for about 13%-25% of total system life cycle costs, can be significantly reduced.

Designing for Producibility

The following methods may be used to achieve a producible design:

- Use standard components
- Use parts designed for ease of fabrication
- Use multifunctional parts
- Use a modular approach
- Minimize assembly and handling requirements
- Minimize the total number of parts

A balanced design must take into consideration the inevitable trade-offs that must be made among various functional areas. Some considerations include:

- Changes made late in the development process or early in the production process are usually the most expensive.
- The highest risk of failure is most likely to occur in the transition from system development to production.

- A product can usually be produced by different methods, each with its own set of costs, and the optimum method should be determined early in the design process.
- Most costs associated with manufacturing are inherent in the design.

Manufacturing Trade-Offs

Manufacturing trade-offs are made throughout the design process among three areas: producibility, cost, and operational requirements. Changes in one can affect the other two, so each trade-off needs to be fully considered before being implemented. In doing so, trade-offs between different product characteristics need to be evaluated. Trade-offs in cost, for example, involve examining the development of alternative designs, required technology and the required industrial base capability. Environmental concerns, factory and support facilities, and the 5 manufacturing elements or "5 Ms" (manpower, machinery, measurement, methods, and materials) are also important trade-off considerations.

Version 1.1 (30 September 2015)

Lesson Summary

Earned Value Management

Learning Objectives

The following learning objectives are covered in this lesson:

- Identify the steps in the development of the initial Performance Measurement Baseline (PMB).
- Identify the relationship of the PMB to program objectives.
- Identify the purpose and content of the Integrated Program Management Report (IPMR).
- Identify performance report tailoring considerations and their effect on reporting.
- Recognize the importance of Earned Value as a management tool.

Earned Value

As you learned in a previous lesson, earned value is an important management tool that is used to monitor and manage the contract and/or project performance by emphasizing the planning and integration of program cost, schedule and performance factors. Although the contractor may choose whatever management system it deems necessary, that system must comply with established American National Standards Institutes' earned value management guidelines (ANSI/EIA-748).

Performance Measurement Baseline

Earned value provides one of the best ways to identify problems, take corrective action, and measure the actual cost of the work accomplished against the planned schedule and cost of the project. This requires the establishment of a Performance Measurement Baseline (PMB), which integrates the integrated master schedule (IMS), the contract work scope, and the contract budget. This baseline is also referred to as the Budgeted Cost of Work Scheduled (BCWS).

The initial basis for the PMB comes from the negotiated cost of the contract and does not include profit or fee. Prospective contractors will estimate cost, schedule, and performance risks after reviewing the scope of work as defined by the Government in the Statement of Work (SOW) or Performance Work Statement, as appropriate. Upon being awarded the contract, the negotiated contract cost provides a good starting point in developing the PMB. Development of the PMB needs to take place immediately to help manage the project.

PMB Development

Using this initial estimate, the PMB is then developed in three steps:

Step 1

In Step 1, the contractor defines or scopes all work to the control account level, using a Work Breakdown Structure (WBS). The control account level is the lowest level of functional responsibility within the contractor's organization. Each control account is assigned to a Control Account Manager (CAM).

Step 2

In Step 2, the contractor creates a detailed schedule or time phased work plan. Each CAM builds a PMB for their respective control account by breaking the work down into work packages and planning packages. Work packages list the detailed job or material items that will be needed to accomplish the required work in the control account, while planning packages identify and budget work expected to be done in the future.

Step 3

In Step 3, the contractor develops a budget for the work scheduled. Each CAM establishes a budget estimate for their control account, which is compared to the other CAM estimates relative to the negotiated cost of the contract. The contractor's project manager then assigns dollar amounts to each CAM based on a comparison of budgeted needs versus available funds.

During this process, the contractor's project manager may withhold a small amount of the overall budget to cover any unknown costs that might arise later in the project. This budgeted dollar amount is known as Management Reserve, or MR.

Integrated Program Management Report

Integrated Program Management Report (IPMR) is used to report earned value data and contractor performance to the PM on all cost or incentive contracts greater than or equal to $20M. The IPMR has seven formats, which provide information on different aspects of the contractor's performance:

Format 1: Work Breakdown Structure

Format 1 contains current and cumulative performance element data broken out by Contract WBS. Any schedule or cost variances that exceed the negotiated dollar or percentage thresholds require a narrative explanation on Format 5.

Format 2: Organizational Categories

In Format 2 contracting efforts are broken down by organizational category.

Format 3: Baseline

Format 3 displays time-phased budgets, showing current period, cumulative value to date, the next six months, and five additional specified periods which take the contract to completion. Changes to future budget periods, application of management reserve, and distribution of Undistributed Budget are also listed here.

Format 4: Staffing

In Format 4 staffing projections for the organizational categories found in Format 2 are listed here, as well as the data for the current period, cumulative, the next six months, and five specified periods extending to contract completion.

Format 5: Explanation and Problem Analyses

Format 5 explains the history of the current status and any actions being taken to address problems that have arisen. It addresses the overall contract status, significant schedule and cost variances between planned and actual achievements, reasons for baseline changes, and rationale for use of management reserve. In response to the contract requirements, the contractor program manager should provide future risk management assessments. This information provides input to the government program manager for future program risk management.

Format 6: Integrated Master Schedule

Format 6 defines and contains the contractor's Integrated Master Schedule (IMS) and is mandatory for all contracts requiring EVMS. The IMS shall include, at a minimum, discrete tasks/activities, consistent with all authorized work, and relationships necessary for successful contract completion.

Format 7: Electronic History and Forecast File

Format 7 defines the supplemental historical and time-phased information in the DoD-approved electronic XML format, by WBS, provided at the same level as the Format 1 (unless otherwise specified in the CRDL) and is mandatory for all contracts requiring EVMS. This time-phased historical and forecast cost submission data is intended to enhance Government analysis beyond the information provide in Format 5 and is required to be submitted at least annually.

IPMR Purposes

DoD will also use the IPMR data for the following purposes:

- Integrate cost and schedule performance data with objective technical measures of performance.
- Identify the magnitude and impact of realized and potential performance problems area that may cause significant cost and schedule variances.
- Provide valid, timely, and accurate contract status information to Government leadership.

EVM is NOT required on Firm Fixed Price (FFP) contracts. EVM is NOT required for any contract with a period of performance of less than 12 months, regardless of value. The use of EVM is NOT recommended for non-schedule based contracts such as Level of Effort (LOE) and Time and Material (T&M) contracts.

A summary of IPMR Format requirements by contract type and value is provided below:

CONTRACT		IPMR REQUIRES	DURATION
Type	**Value ($)**	**Formats**	**Period of Performance**
Firm-Fixed Price (FFP)*	At Any Value	**REQUIRED** None	Not Applicable
FFP – Level of Effort (LOE)	At Any Value	**REQUIRED** None	Not Applicable
Other – Time & Material (T&M)	At Any Value	**REQUIRED** None	Not Applicable
Any Cost Plus and/or Fixed-Price Incentive	Greater than or equal to $100 Million**	**REQUIRED** All Formats (**1 thru 7**)	Greater than 12 months
Any Cost Plus and/or Fixed-Price Incentive	Greater than or equal to $50 Million BUT less than $100 Million	**REQUIRED** All Formats (**1 thru 7**)	Greater than 12 months
Any Cost Plus and/or Fixed-Price Incentive	Greater than or equal to $20 Million BUT less than $50 Million***	**REQUIRED** Formats **1, 5, 6, & 7**; **OPTIONAL** Formats **2, 3, & 4**	Greater than 12 months
Any Cost Plus and/or Fixed-Price Incentive	Less than $20 Million	**REQUIRED** None (optional) If optioned for use by PM – Formats **1, 5, & 7** are recommended; Format **6** may be recommended as well	Greater than 12 months

* Format 6 may be required for FFP contract.

** $100M or greater requires formal EVMS validations and performance of DCMA surveillance.

*** All cost plus and/or fixed-price incentive contracts greater than $20 million must be compliant with EIA-748.

Lesson Summary

Budgeting Process

Learning Objectives

The following learning objective is covered in this lesson:

- Identify the key events in the budgeting phase, including the preparation, review and decision process associated with the three major documents of the phase: Budget Estimate Submission (BES), Resource Management Decision (RMD), and Reclamas.

Budgeting Phase

The budgeting phase of the PPBE process focuses on program execution to determine near-term funding requirements. Budgeting is a calendar-driven process, resulting in the DoD portion of the President's Budget, which is submitted to Congress in February each year.

Program Objectives Memorandum and Budget Estimate Submission

The services prepare their combined Program Objectives Memorandum (POM) and Budget Estimate Submission (BES). The POM and BES update the Future Years Defense Program (FYDP). The BES covers one year (such as FY 12).

The BES is submitted to the OSD Comptroller. Occasionally the OSD Comptroller will send a list of "Advance Questions" about specific areas of the budget.

Draft Resource Management Decision

In the fall, after receiving responses to the advance questions, analysts from the OSD Comptroller and the Office of Management and Budget (OMB) hold hearings to review appropriations or specific programs. The analysts typically examine program pricing and phasing, compliance with funding policies, and budget execution. After reviewing these areas, the OSD Comptroller analyst may prepare a draft Resource Management Decision (RMD). The draft RMD is used to make adjustments to the BES, generally reducing the amount of funding.

Reclama

The draft RMD is provided to the services and defense agencies for comment, at which point they are allowed to provide an alternate position, known as a reclama. A reclama provides an opportunity to explain problematic areas in the budget and refute proposed budget cuts. Reclamas should always be based on fact and provide an objective evaluation of the implications of the proposed cuts.

Final RMD

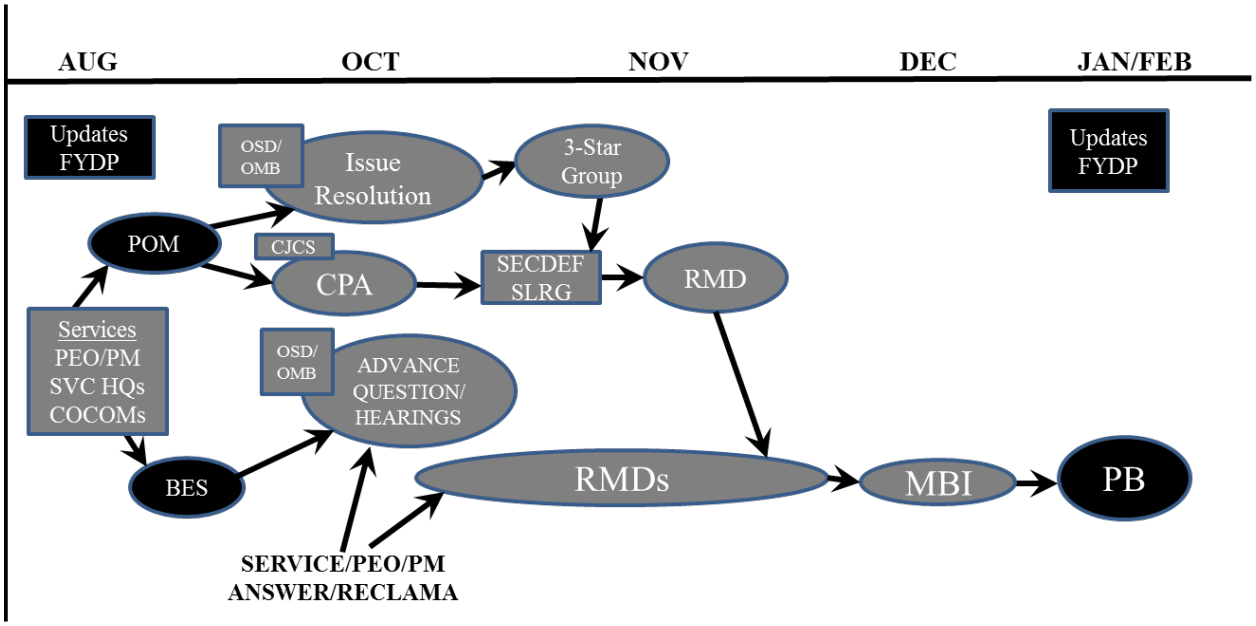
After considering the reclama, the OSD analyst makes the decision whether to withdraw, amend, or submit the original version of the RMD. If not withdrawn, this final draft version of the RMD will include all information regarding the original RMD and the associated reclama. It is then sent to the DEPSECDEF, who ultimately makes the decision to sign off, thus finalizing the RMD.

Execution Review

While programming and budgeting are ongoing, the Execution Review phase is also ongoing. The results of execution review will be used to make decisions about how to best allocate resources.

President's Budget

The RMD and changes that occur during programming will be incorporated as part of the DoD portion of the President's Budget. The FYDP is then updated to reflect the President's Budget, thus ending the budgeting phase of the PPBE process.



Version 1.0 (11 July 2014)

Lesson Summary

Design Changes

Learning Objectives

The following learning objectives are covered in this lesson:

- Identify how instability of user capability needs, design, and production processes impact program cost and schedule.
- Identify the purpose of specific technical reviews and their relationship to the acquisition process.
- Identify the roles, responsibilities, and methods for interface control and technical data management.
- Recognize how configuration management impacts all functional disciplines (e.g., test, logistics, manufacturing, etc.).
- Identify the impact on configuration management when commercial items are used in the system.
- Relate the different types of program unique specifications to their appropriate configuration baselines and technical review requirements.
- Trace the maturation of system design information as it evolves through the acquisition life cycle of a system.
- Identify the relationship between configuration baselines, specifications, and configuration management planning.
- Identify key acquisition best practices, including commercial practices that impact the relationship between government and industry.

Technical Reviews

Technical reviews are conducted throughout the acquisition life cycle to reduce program risk. They are event-driven, not schedule-driven, and help determine whether to proceed with development or production.

With the exception of the PDR and CDR, which are mandatory technical reviews for any program that is not initiated at MS C, not every type of technical review is required for every program. The type and number of technical reviews can be tailored and the key to this tailoring is determining what technical reviews are appropriate given the circumstances of your particular program.

Technical reviews are used to clarify design requirements, assess design maturity, and evaluate the system configuration at various points in the development process. They provide a forum for communication across different disciplines in the system development process and establish common configuration baselines from which to proceed to the next level of design.

Some of the Major Types of Technical Reviews

- System Requirements Review (SRR), a formal system-level review in which the system specification is evaluated to ensure that system requirements are consistent with the preferred concept and available technologies and that a mutual understanding between the government and the contractor exists.
- Systems Functional Review (SFR), a formal review of the conceptual design of the system to establish its capability to satisfy the requirements. It establishes the Functional baseline.
- Preliminary Design Review (PDR), in which the top-level design for each configuration item function and interface is evaluated to determine if it is ready for detailed design. It confirms the Allocated baseline. Unless waived by the MDA, a PDR is required prior to MS B and Program Initiation.
- Critical Design Review (CDR), assesses design maturity, design build-to-code or code-to documentation and remaining risks and establishes the initial product baseline. During the EMD phase, the CDR will be used as the decision point in which the detailed Product Baseline is evaluated to determine if system design documentation is good enough to begin production (hardware) or final coding (software). It confirms the initial Product baseline.
- Test Readiness Review (TRR), in which test objectives, procedures and resources are evaluated to determine if the system is ready to begin formal testing.

Configuration Management

Configuration management is one of the technical management processes that is used in the systems engineering process to control the design of a product as it evolves from a top-level concept into a highly detailed design. Through configuration management, we ensure that designs are traceable to requirements, interfaces are well defined and understood, change is controlled and documented, and product documentation is consistent and current.

Configuration management involves development of program unique specifications and other technical data to document the design. As design requirements are finalized at different levels of detail, configuration baselines are established to formally document those requirements and to define an item's functional and physical characteristics. The baselines progress from the overall system level (functional baseline) to the more specific configuration item level (allocated baseline) and then down to the detailed level (product baseline).

The highest level baseline is the functional baseline. The functional baseline includes the overall system specifications, such as the mission and technical performance requirements. It also includes system to system, or external interface definitions. This level of baseline defines system level requirements and is documented primarily by the 'system' specification.

The next level of baseline is the allocated baseline. The allocated baseline defines design requirements for configuration items below the system level. This baseline includes Item Performance specifications, which describe the performance characteristics of a "configuration item," including its form, fit, and function. This level of baseline, often referred to as the 'design to' spec, does not include detailed requirements, but focuses on the specifications necessary for the system to meet performance parameters, including interface requirements.

Finally, the lowest level of baseline that concerns the Government is the product baseline. The product baseline includes the design requirements that specify how to build the system, including details of processes (hardware and software), procedures, and materials used in fabrication. This level of baseline is often referred to as the 'build to' baseline and is usually controlled by the contractor.

Baseline	Specifications	Examples for Firebird UAV
Functional ("system" specification)	Overall system performance requirements, including interfaces	Hardware and software requirements analysis for the Night vision requirement
Allocated ("design to" specification)	Item performance specification. Performance characteristics of specific configuration items, including form, fit, function requirements.	Specific light level and resolutions that are required of a digital camera for the night vision capability. Hardware and software interface requirements for camera to attach and interoperate with air vehicle.
Product ("build to" specification)	Item detail specifications. Hardware and Software process, procedure, material details, technical documentation.	Camera shutter design details. Video transport circuit detailed design including required software coding. Drawing showing locking mechanism for camera body.

The Government must determine which baselines should come under Government control. Generally speaking, the Government maintains control of the functional, or system-level baseline; either the Government or contractor; can maintain the allocated baseline; and the contractor is usually responsible for the product, or 'build-to' level baseline and below.

Interface Management

Interface management involves the control and definition of the boundaries at which product subsystems come into contact with other components of the system. Effective interface management involves identifying, developing and maintaining the external and internal interfaces necessary for system operation. Interface management can become a configuration management challenge when a product is modified.

The contractor is usually responsible for design and control of internal interfaces, while the Government is responsible for external interfaces.

Interface Control Working Group

An Interface Control Working Group (ICWG) is often used to establish formal communication links between Government and contractor personnel involved in system interface design.

Supporting the System

Once a system is fielded, configuration management documentation becomes the basis for supporting the system, whether that support is provided by the contractor or by the Government. Interoperability and maintenance issues can become very problematic if configuration management isn't done properly. Even minor changes to a commercial item can create configuration challenges and impact logistics, testing, production and other functional areas.

Technical Data Package

The contractor will ultimately document the functional, performance, and physical characteristics of their product in a Technical Data Package (TDP). Ensuring that the TDP is comprehensive and updated regularly is especially important if the Government is going to maintain or modify the system.

Version 1.2 (31 March 2015)

Lesson Summary

Software Problems

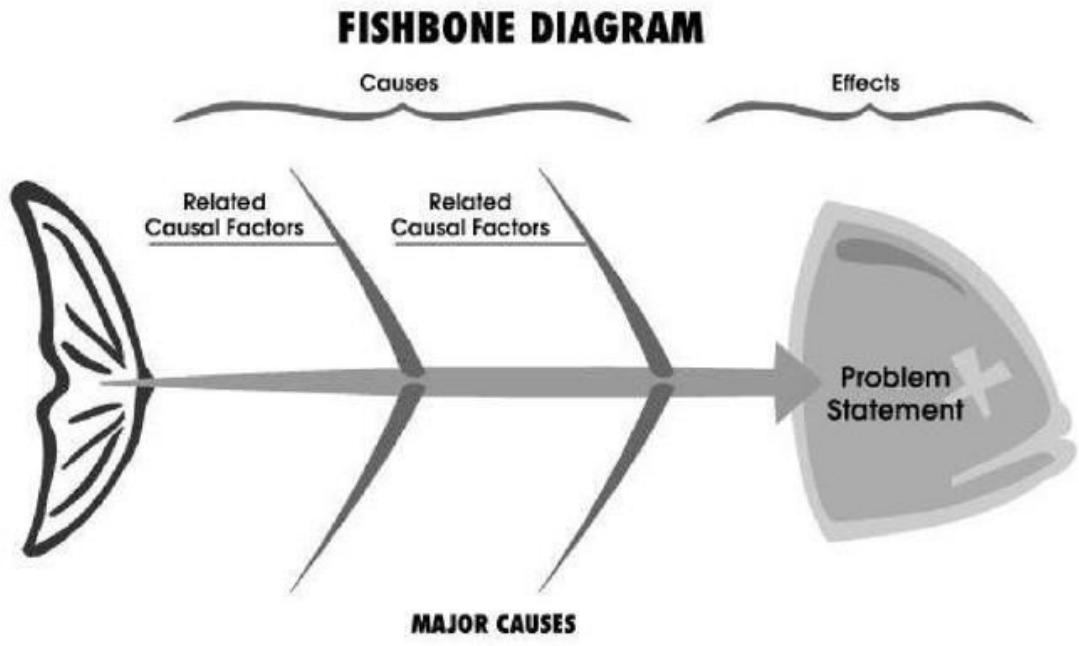
Learning Objectives

The following learning objectives are covered in this lesson:

- Apply a generic problem-solving model to an acquisition situation.
- Apply one or more selected qualitative tools (e.g., fishbone diagram) to resolve a problem.
- Identify developer practices essential for creation of high quality software.
- Identify the requirements for interoperability testing.

Cause and Effect Diagram (Fishbone Diagram)

One problem-solving technique is the cause and effect diagram or **"fishbone" diagram**. By analyzing all the possible causes of a problem, the fishbone diagram focuses on determining the root cause of a problem, rather than on symptoms or solutions. Typically, the fishbone diagram begins with a statement of the problem in a box on the right side of the diagram-the "head" of the fish. Then categories of major causes are identified and drawn to the left-the "bones" of the fish. These major causes are broken down into all the related causal factors that might contribute to the major causes. Finally, the causal factors are examined and narrowed down to the most significant elements of the problem to determine the ultimate cause or causes.



Software Best Practices

The Software Program Managers Network has identified several software best practices based on interviews with software experts and industry leaders. Here is a synthesized list of some of those characteristics, which are essential for the creation of high quality software:

Adopt Continuous Program Risk Management

Risk management is a continuous process beginning with the definition of the concept and ending with system retirement. Risks need to be identified and managed across the life of the program.

Estimate Cost and Schedule Empirically

Initial software estimates and schedules should be looked on as high risk due to the lack of definitive information available at the time they are defined.

Use Metrics to Manage

All programs should have in place a continuous metrics program to monitor issues and determine the likelihood of risks occurring. Metrics information should be used as one of the primary inputs for program decisions.

Track Earned Value

Earned value requires each task to have both entry and exit criteria and a step to validate that these criteria have been met prior to the award of the credit. Earned value credit is binary with zero percent being given before task completion and 100 percent when completion is validated.

Track Defects against Quality Targets

All programs need to have pre-negotiated quality targets, which is an absolute requirement to be met prior to acceptance by the customer. Programs should implement practices to find defects early in the process and as close in time to creation of the defect as possible and should manage this defect rate against the quality targets. Meeting quality targets should be a subject at every major program review.

Treat People as the Most Important Resource

A primary program focus should be staffing positions with qualified personnel and retaining this staff through the life of the project. The program should not implement practices (e.g., excessive unpaid overtime) that will force voluntary staff turnover. The effectiveness and morale of the staff should be a factor in rewarding management.

Adopt Life Cycle Configuration Management

All programs, irrespective of size, need to manage information through a preplanned configuration management (CM) process. This discipline requires as a minimum:

- Control of shared information
- Control of changes
- Version control
- Identification of the status of controlled items (e.g., memos, schedules) and
- Reviews and audits of controlled items

Manage and Trace Requirements

Before any design is initiated, requirements for that segment of the software need to be agreed to. Requirements need to be continuously traced from the user requirement to the lowest level software component.

Use System-Based Software Design

All methods used to define system architecture and software design should be documented in the system engineering management plan and software development plan and be frequently and regularly evaluated through audits conducted by an independent program organization.

Ensure Data and Database Interoperability

All data and database implementation decisions should consider interoperability issues and, as interoperability factors change, these decisions should be revisited.

Define and Control Interfaces

Before completion of system-level requirements, a complete inventory of all external interfaces needs to be completed. Internal interfaces should be defined as part of the design process. All interfaces should be agreed upon and individually tested.

Design Twice, Code Once

Traceability needs to be maintained through the design and verified as part of the inspection process. Design can be incrementally specified when an incremental release or evolution life cycle model is used provided the CM process is adequate to support control of incremental designs.

Assess Reuse Risks and Costs

The use of reuse components, COTS (Commercial Off-The-Shelf), GOTS (Government Off- The-Shelf) or any other non-developmental items (NDI) should be a primary goal, but treat any use as a risk and manage it through risk management.

Inspect Requirements and Design

All products that are placed under CM and are used as a basis for subsequent development need to be subjected to a formal inspection defined in the software development plan. The program needs to fund inspections and track rework savings.

Manage Testing as a Continuous Process

All testing should follow a preplanned process, which is agreed to and funded. Every test should be described in traceable procedures and have pass-fail criteria.

Compile and Smoke Test Frequently

Smoke testing should qualify new capability or component only after successful regression test completion. All smoke tests should be based on a traceable procedure and run by an independent organization (not the engineers who produced it). Smoke test results should be visible and provided to all project personnel.

Interoperability Testing

Interoperability problems can best be identified through the use of actual, live systems to mitigate risk. Joint interoperability is defined as the ability of systems to provide services to and accept services from other systems and to use the services exchanged to enable them to operate effectively together.

Through actual testing, Joint Interoperability Test Command (JITC) is responsible for verifying the interoperability of systems to the performance parameters outlined in the lCD, CDD, CPD and ISP.

Version 1.1 (01 December 2014)

Lesson Summary

APB Breaches

The following learning objectives are covered in this Lesson:

- Identify when program deviations occur and the actions that should be taken by the Program Manager.
- Relate the Acquisition Program Baseline (APB) to planning, control and risk management in attaining cost, schedule and performance goals.

Program Deviation

A program deviation occurs when the Program Manager has reason to believe that the current estimate for a given cost, schedule or performance parameter does not meet the threshold value specified for that parameter in the Acquisition Program Baseline.

The PM must follow certain procedures whenever this occurs:

- The PM must **immediately** inform the Milestone Decision Authority (MDA) when a program deviation occurs.
- Within **30 days** of the deviation, the PM must explain to the MDA the reason for the deviation and what steps need to be taken to bring the program back on track.
- Within **90 days** of the deviation, one of the following scenarios must take place:
    - The program is brought back on track; or
    - A new APB is approved, changing only the parameters that were deviated; or
    - An OIPT-level review is conducted to evaluate the PMs proposed baseline revisions, and feedback is given to the MDA, or in the case of a major program, to the Defense Acquisition Executive; or
    - If it's not possible for at least one of these actions to take place within 90 days, then the MDA should hold a formal program review to determine the status of the program.

Interrelatedness of APB Parameters

Cost, schedule, and performance parameters are interrelated, and a change in one parameter can affect the others. For example, the materials needed for a lighter aircraft may cost more and take longer to design and manufacture than materials in a heavier aircraft. In that case, performance would affect both cost and schedule parameters. Therefore it is important to involve all the key stakeholders when considering changes to the APB.

Version 1.1 (30 June 2015)

Lesson Summary

Reprogramming Funds

The following learning objectives are covered in this lesson:

- Select the appropriate public law (i.e., Misappropriation Act, Anti-Deficiency Act, Bona Fide Need) that applies to the use of appropriated funds under specific circumstances.
- Given a funding shortfall, apply the rules governing reprogramming of appropriated funds in each appropriation category to resolve the problem.
- Identify the role of Early Operational Assessment (EOA) and Operational Assessment (OA) in reducing program risk.
- Identify the risks and benefits associated with integrated Developmental Testing/Operational Testing (DT/OT).

Appropriated Funds Laws

Congress has passed laws to ensure the proper use of the funds they make available for defense acquisition programs:

Misappropriation Act

The Misappropriation Act states that funds appropriated by Congress can only be used for the programs and purposes for which the appropriation was made. Using Research, Development, Test and Evaluation (RDT&E) funds to pay for the procurement of items, for example, would violate the Misappropriation Act.

Anti-Deficiency Act

The Anti-Deficiency Act prohibits the obligation of funds in excess of an appropriated amount or in advance of receiving an appropriation. In other words, you can't spend more funds than you have or before you have them. Incurring a contractual obligation without having the funds to cover it, for example, would violate the Anti-Deficiency Act.

Bona Fide Need Rule

The Bona Fide Need Rule states that funds appropriated for a particular area can only be used during the period in which the appropriation is available for new obligations. If a research and development contract were awarded with FY13 RDT&E funds, and a new requirement arises inFY15 beyond the scope of that contract, then using FY13 RDT&E funds to pay for the new requirement would violate the Bona Fide Rule.

Reprogramming Funds

Although there are strict rules governing the use of appropriated funds, Congress recognizes that there are certain situations where some flexibility is needed. Reprogramming is the use of funds for purposes other than those intended by Congress at the time originally appropriated. Note that reprogramming only applies to funds that have already been appropriated by Congress.

Below-Threshold Reprogramming

Prior approval from Congress is required to move funds between appropriations, to increase the quantities of major systems procured, new starts, or for designated special interest items. However, most reprogramming actions in DoD are approved at the service or agency level, without the involvement of Congress, using below-threshold reprogramming. Below-Threshold reprogramming allows the transfer of funds among programs within an appropriation category, subject to certain limitations. Up to $20 million of procurement funds can be transferred into a line item, and up to $10 million of RDT&E funds can be transferred into a program element, through below-threshold reprogramming.

Operational Assessments

Early Operational Assessments (EOA) can be conducted at any time during development, but at least one is typically conducted sometime before the Critical Design Review occurs in the Engineering and Manufacturing Development (EMD) phase. Using prototype systems, the EOA identifies potential operational effectiveness and suitability issues during system development. An Operational Assessment (OA) is conducted before Milestone C. Using production representative articles, the OA provides operational effectiveness and suitability data before low rate initial production is begun.

Combined Developmental and Operational Testing

Sometimes developmental and operational testing are integrated to save resources, time and money. DT and OT are typically integrated when the data, resources, objectives, test scenarios, and measures of effectiveness of both tests are similar and compatible.

DoD policy encourages integrated testing as long as the objectives of both types of testing are met. Integrated testing eliminates redundant activities and raises operational concerns in time to make changes in the system design. However, integrated tests require extensive coordination, are more difficult to design, and risk compromising test objectives.

Integrating DT and OT does not remove the requirement to conduct initial operational test and evaluation (IOT&E), which is required by law for ACAT I and ACAT II programs. IOT&E uses mature production-representative systems and typical user personnel in a scenario that is as realistic as possible. Successful IOT&E is required for the milestone decision authority to make the full-rate production decision.

Version 1.2 (30 June 2015)

Lesson Summary

Reviews, Simulations, and Test

The following learning objectives are covered in this lesson:

- Recognize the importance of modeling and simulation in the defense acquisition process.
- Distinguish among various types of Developmental Test and Evaluation (DT&E) (e.g., Production Qualification Tests, Production Acceptance Test and Evaluation, etc.).
- Recognize the relationship between risk management and exit criteria.
- Identify the information required for a milestone review.

Exit Criteria

One way to effectively manage acquisition risk is through the use of exit criteria, which serve as a litmus test as to whether the program is on track to achieve its goals. In order for exit criteria to be meaningful, they must be unique to not only the program itself, but to each phase of the program. Exit criteria are proposed by the Program Manager and approved by the Milestone Decision Authority (MDA).

Exit criteria can take many forms. However, the criteria should be measurable and reflect progress made in high risk areas of the program. Examples include the achievement of technical capabilities as seen in test results or the maturity of a manufacturing process. Thus, exit criteria are event-driven and considered at program reviews throughout the life of a program. They are critical "show-stoppers;" failure to meet an exit criterion could prevent a program from making further progress.

Milestone Reviews

Milestone reviews are conducted by the MDA to initiate technology maturation and risk reduction, to authorize program initiation and entry into the EMD phase, and later to commit to production and deployment. Information for milestone reviews may be required by statute or regulation. The specific information required for each milestone review can be found in Enclosure 1 of DoDI 5000.02.

Modeling and Simulation

The use of modeling and simulation (M&S) can be very helpful during the acquisition process. Used as a predictor of future capabilities, M&S can be an inexpensive way to test various capabilities. Models and simulations can also be modified and reused later in the acquisition process, which should avoid costs in the long run.

However, M&S should not be used as a substitute for good test data. While M&S can be very effective, simulations only provide predictions of a system's performance and effectiveness. Thus, by combining M&S data with the empirical, measurable data provided by T&E, the two processes enhance each other and should result in long term efficiencies and cost savings.

Developmental Testing and Evaluation

Developmental Testing and Evaluation (DT&E) can take many forms during the acquisition process, depending upon what stage of the life cycle the program is in.

Component Testing

Component tests take place on individual system parts before the parts are merged into the system as a whole. Component testing is conducted both on hardware items and on software items before they are integrated with system hardware.

Integration Testing

Integration testing is used to assess compatibility of individual hardware and software components as they are aggregated to form subsystems or systems.

Environmental Testing

Environmental testing, sometimes referred to as the "shake-rattle-roll" part of the testing process, attempts to define how different components react under various conditions, such as temperature and shock.

Production Qualification Testing

Production Qualification Testing (PQT is conducted on initial production articles to verify the effectiveness of the manufacturing process.

Production and Acceptance Testing and Evaluation

Production and Acceptance Testing and Evaluation (PAT&E) is conducted on production items to verify that these items have met contract requirements.

Modification Testing

Modification testing can be used during production, or following system deployment, to determine the need for or benefits of any system changes.

Live Fire Test and Evaluation

Live Fire Test and Evaluation (LFT&E) provides a realistic assessment of weapon platform/crew vulnerability and lethality of conventional munitions/missiles. LTF&E is required for all ACAT I and ll programs or modifications that impact the system's vulnerability or lethality in combat. It is mandated by Congress, and funded by the program office. Results must be reported to Congress prior to a Full Rate Production Decision in the LFT&E Report.

Lesson Summary

Contractor Performance Measurement

The following learning objectives are covered in this lesson:

- Given performance data, select and compute appropriate performance status indicators.
- Given performance data, detect and analyze the impact of significant problem areas, based on the status indicators.
- Given performance data, calculate an estimate of cost at completion.
- Recognize the importance of Earned Value data in external reporting.

Performance Status Indicators

There are various performance status indicators used in earned value management to tell whether a program is on track or not.

Budgeted Cost of Work Scheduled (BCWS)

BCWS indicates the value of work planned to be accomplished or planned value.

Budgeted Cost of Work Performed (BCWP)

BCWP indicates the value of work accomplished or the earned value.

Actual Cost of Work Performed (ACWP)

ACWP indicates the cost of work accomplished or actual cost.

Schedule Variance (SV)

SV equals the difference between the value of work accomplished and the value of work planned to be accomplished. It is calculated by subtracting the budgeted cost of work scheduled from the budgeted cost of work performed.

SV = BCWP - BCWS

A negative schedule variance is unfavorable and indicates that less work was accomplished than planned, while a positive schedule variance shows that more work was accomplished than planned. The program's critical path schedule must be reviewed to determine the impact of these schedule variances to the program. (Note that the schedule variance is denominated in dollars.)

Cost Variance (CV)

CV indicates whether the work accomplished cost more or less than planned. It is calculated by subtracting the actual cost of work performed from the budgeted cost of work performed.

CV = BCWP - ACWP

A negative cost variance is unfavorable and indicates that more money was spent for the work accomplished than was planned. This has the potential to put the program over budget if the trend continues, and may require the government to provide additional money to complete the program. A positive cost variance is favorable and indicates that the work accomplished cost less than planned

Performance Trends

We can also identify performance trends to see whether performance is improving or worsening over time and at what rate. This can be done for the overall program or for a specific activity within the program.

Schedule Performance Index (SPI)

SPI indicates the efficiency with which the work has been accomplished in comparison to the work planned. For example, we may be functioning at only 0.8 or 80% efficiency of what we had planned to accomplish. It is calculated by dividing the budgeted cost of work performed by the budgeted cost of work scheduled.

SPI = BCWP/BCWS

Cost Performance Index (CPI)

CPI tells the cost efficiency. It compares the budgeted cost of work that has been accomplished to the actual cost of the accomplished work. For example, if our CPI is 0.75, we are accomplishing only 75 cents worth of work for every dollar we spend. It is calculated by dividing the budgeted cost of work performed by the actual cost of work performed.

CPI = BCWP/ACWP

Ideal CPI for a project is 1.0. Any activity with a CPI of less than 1.0 will rarely be improved over time. In fact, a program's CPI performance of less than 1.0 is often non-recoverable.

Cumulative CPIs and SPIs

Cumulative CPIs and SPIs are usually less than 1.0 for most programs. Current period SPIs and CPIs for individual tasks can exceed 1.0, and exhibit positive and negative elements. When cumulative performance (CPI and SPI) falls below 1.0, the government needs to discuss the performance status with the contractor as part of risk management. Earned Value industry guidelines specifically state that management reserve will NOT be used to offset negative variances.

Budget at Completion

Budget at Completion (BAC) is the sum of all authorized budgets for the contract scope of work. The project's scope of work forms the performance measurement baseline (PMB), which projects the cost to complete the entire program. The BAC equals the sum of all the allocated budgets plus any undistributed budget (management reserve and profit/fee not included). We use the BAC to determine the percent of the program spent and completed.

Percent Spent (% Spent)

Percent Spent indicates how much of the program budget has been spent to date relative to the total amount of the project's budgeted funds. It is calculated by dividing the actual cost of work performed to date by the total amount expected to be spent on the program (the budget at completion).

% Spent = (ACWP/BAC) * 100

Percent Complete (% Complete)

Percent Complete indicates how much of the total program has been completed to date relative to the total amount of work to be performed. It is calculated by dividing the budgeted cost of work performed to date by the total amount expected to be spent on the program (the budget at completion).

% Complete = (BCWP/BAC) * 100

Percent Scheduled (% Scheduled)

Percent Scheduled indicates where the program should be based on a point in time. It is calculated by dividing the budgeted cost of work scheduled to date by the budget at completion.

% Scheduled = (BCWS/BAC) * 100

If the Percent Spent is greater than the Percent Complete, the program is going to run out of funds before the end of the project if it continues on the current trend. Conversely, if the Percent Complete is greater than or equal to the Percent Spent, the project has sufficient funds if it continues on the current trend.

For example, if the percent complete is 50% and percent spent is 66%, we know we have a problem because we are spending at a faster rate than the project's work is being completed.

Note: Don't confuse Percent Spent and Percent Complete with the SPI and CPI. Percent Complete and Percent Spent indicate program status, looking at the entire program from beginning to end. SPI and CPI indicate efficiency trends and look at a program up to a certain point in time.

Estimate at Completion

Estimate at Completion (EAC) is the 'current' estimate of what the program will cost when completed. The EAC is based on the actual cost of work performed to date plus an estimate of the work remaining. It is calculated by adding the actual cost of work performed (ACWP) to the estimated cost to complete the remaining work of the program.

EAC = ACWP + Estimated Cost to Complete

The EAC can be calculated as follows: EAC is equal to the ACWP plus the BAC minus the BCWP divided by a performance factor. One method to calculate EAC is called $EAC_{(CPI)}$, or EAC(Low), where the performance factor is just the cumulative CPI. This is an optimistic EAC and represents to lower end of the EAC range.

$$EAC_{(CPI)} = ACWP + [(BAC - BCWP) / (CPI)]$$

Another method to calculate EAC is called $EAC_{(COMPOSITE)}$, or EAC(High), where the performance factor is the CPI multiplied by the SPI. Since CPI and/or SPI are usually below 1, this is a pessimistic EAC and represents the higher end of the EAC range.

$$EAC_{(COMPOSITE)} = ACWP + [(BAC - BCWP) / (CPI \times SPI)]$$

Both the Government and the contractor calculate EACs. The contractor's EAC is often referred to as the Latest Revised Estimate (LRE). Under normal circumstances, The contractor's EAC should typically fall somewhere between the $EAC_{(CPI)}$ and $EAC_{(COMPOSITE)}$ values.

To-Complete Performance Index

To-Complete Performance Index {TCPI (target)} is a powerful but often misunderstood EVM metric. The TCPI is an EVM metric computed by dividing the value of the work remaining by the value of the cost target remaining. The cost target remaining value is tied to some financial goal set by management (Government or Contractor).

In other words the TCPI metric represents the cost efficiency from the present time or time now, until the end of the contract required to achieve management's financial goal. The management goals are usually defined as either the Contractor's EAC (also known as LRE), the contract's BAC, or the Government's "Most Likely" EAC.

TCPI (Target) = Work Remaining / Cost Remaining

or

(BAC – BCWP) / (COST TARGET-ACWP)

Note: To determine the TCPI for any of the cost targets listed above, simply replace the Cost Target value with either BAC, EAC, or the LRE value.

TCPI for BAC

TCPI for the Budget at Completion {TCPI (BAC)} is an index that shows what efficiency is required to accomplish the remaining work within the contract budget.

TCPI for LRE

TCPI for the Latest Revised Estimate {TCPI (LRE)} is an index that shows what efficiency is required by the Contractor to accomplish the remaining work within their expected cost target estimate.

TCPI for EAC

TCPI for Estimate at Completion {TCPI (EAC)} is an index that shows what efficiency the Government thinks is required to accomplish the remaining work within some identified cost target estimate (Government's "Most Likely'' EAC).

The TCPI is correlated with the cumulative CPI; it takes the cost efficiency experienced to date, as reflected by the cumulative CPI, and determines what level of performance efficiency will be required to complete the project within available budget.

If the cumulative CPI is 0.8 or 80%, in order to stay within our budget, we must achieve a performance factor of 1.2, or work at an efficiency of 120% for all the remaining work in order to complete the project at the BAC. This means the contractor must work 40% more efficiently than its current cumulative CPI of 80%.

To calculate TCPI (BAC) we divide the budgeted cost of the work not yet completed by the amount of budget remaining. In other words, we subtract the BCWP from the BAC then divide that difference by the difference between the BAC and the ACWP.

$$\text{TCPI (BAC)} = (\text{BAC} - \text{BCWP}) / (\text{BAC} - \text{ACWP})$$

DoD analysts have determined that after 20% into a program, the cumulative CPI rarely improves. Therefore, achieving a TCPI that is greater than 5% (or 0.05) of the CPI is unlikely; this means we may have to restructure the program in order to obtain an executable program.

Lesson Summary

Integrated Baseline Review

The following learning objectives are covered in this lesson:

- Identify the primary factors that the government should review to evaluate the contractor's Performance Measurement Baseline (PMB) during an Integrated Baseline Review (IBR).
- Identify the three reasons for Performance Measurement Baseline (PMB) changes—contract changes, internal re-planning, and formal reprogramming--and recognize the impact of each.

Performance Indices

The Cost Performance Index (CPI) and Schedule Performance Index (SPI) indicate the performance efficiency factors that the contractor has achieved to date. Anytime the CPI or SPI are running significantly below 1.0, rebaselining may be necessary in order to complete the program.

Generally, a CPI or SPI falling 10% or more below 1.0 is considered significant. The To-Complete Performance Index (TCPI) indicates the efficiency factor that the contractor must achieve from "time now" to meet the Budget At Completion (BAC) or Estimate At Completion (EAC).

A TCPI greater than 1.0 indicates the contractor must work more efficiently that they have in the past to stay within the BAC or meet the EAC. These performance indices may indicate the need to conduct an Integrated Baseline Review (IBR).

Integrated Baseline Review

The IBR assesses the validity of the PMB and identifies the risks associated with executing to the current PMB. Participants in an IBR typically include the Government PM and technical staff, along with the related contractor's staff. During an IBR, the primary factors that are evaluated include:

- Technical scope of the PMB
- Program schedule requirements
- Effective resource allocation to ensure that the work can be accomplished

The IBR is not just a single event – it is a continuous process that revalidates the PMB. The revalidation of the baseline is an integral part of Government/contractor management and maybe included as an agenda item in subsequent program management reviews. IBRs should be used as necessary throughout the life of a program to facilitate and maintain a mutual understanding of:

- The scope of the PMB consistent with authorizing documents
- The management control processes
- The Risks in the PMB associated with cost, schedules, and resources
- Corrective actions where necessary

PMB Changes

There may be considerable risks associated with the current PMB, indicating a need to rebaseline the program in order to make it executable. Rebaselining is an unfortunate term that causes no end of confusion among experienced practitioners and the inexperienced alike. Rebaselining the PMB can be caused by any one of the following three reasons:

- Contract changes: only apply to changes/contract modifications directed by the Government, not the contractor.
- Internal replanning: occurs when the contractor's original plan needs adjustment in response to problems or the opportunity to capitalize on efficiencies. The remaining in-scope work is then re-planned by the contractor PM using the remaining budget and schedule.
- Formal reprogramming: occurs when the remaining budget and schedule is unrealistic; the contractor requires more time and dollars; the PMB exceeds the contract target cost and an over target baseline (OTB) occurs -- the current contract budget is insufficient and the original objectives cannot be met.

Replanning should happen whenever the shape of the future baseline needs revision to reflect realism, and should never - theoretically - modify the shape of the baseline for time past unless that work was never begun. Replanning does not alter scope, schedule, or budget at the PMB, although it changes the time-phasing of the existing scope and budget. Revisions to the baseline that exceed the negotiated scope/budget or schedule result in over-target baselines or over-target schedules (OTS). It is a fiction that if the government does not approve an OTB or an OTS that it does not exist.

Formal reprogramming changes scope, schedule, budget, or all three. On a DOD contract, it requires notification to the customer, which in practice becomes approval from the customer, although that is not strictly the intent of the requirement. Formal reprogramming should never be undertaken to eliminate variances for the sake of "starting over" unless the baseline is so unrealistic that retaining the variances would forever skew performance data so much as to be unusable.

STUDENT NOTE: Be advised that in this instance, we are talking about reprogramming the PMB, not reprogramming appropriated funds from one program to another; however, we may need to do that later in order to cover any additional program scope.

Lesson Summary

Budget Execution

The following learning objectives are covered in this lesson:

- Given a scenario, track budget execution through the commitment, obligation, and expenditure process.
- Identify the use and importance of obligation and expenditure plans.
- Assess the impact of the failure to execute funds in accordance with program plans.

Budget Execution Process

In the budget execution process, the following steps are taken:

Commitment

A commitment is an administrative reservation of funds, made upon receipt of a request for spending. Commitment occurs upon certification that funds are available in the correct appropriation, in the correct fiscal year, and in the correct amount to cover the anticipated obligation.

Obligation

An obligation is a "legal reservation" of funds, tying the government to a liability, such as a contract for goods or services. Obligation occurs when a contract is signed or when orders are placed.

Expenditure

An expenditure is a payment of some part or all of an obligation. Expenditure occurs when a check is issued, or when funds are electronically transferred, to a contractor in response to an invoice or bill for costs incurred, services rendered, or products delivered.

Outlay

An outlay is a payment by the U.S. Treasury to the contractor. Outlay occurs when a check is cashed or when funds are electronically transferred from the Government to the contractor. (In electronic funds transfer, expenditure and outlay happen simultaneously.)

Participants in Budget Execution Process

A number of players are involved in the execution of funds. After the Comptroller commits the funds by certifying their availability, the Contracting Officer obligates the funds by awarding the contract or signing purchase orders.

Then the contractor performs the work and submits a Material Inspection and Receiving Report to the Quality Assurance Representative (QAR) from the Contract Management Office, if deliverables are received at the contractor's plant, or to the Contracting Officer's Representative (COR), if deliverables are received at the program management office.

The QAR or COR verify that the deliverables were received and accepted and inform the Administrative Contracting Officer (ACO). The contractor submits an invoice to the ACO.

The ACO certifies that the invoice is correct, and then forwards the invoice to the finance office to make payment. The ACO also assures that the contractor gets paid in a timely manner.

The Finance and Accounting Office in tum expends the funds by check or electronic funds transfer. Finally, the U.S. Treasury outlays the funds when the cash is provided to the contractor.

Spending Plan

Failure to make timely payment to a contractor can cause serious cash flow problems for the contractor. In addition, poor expenditure or outlay rates are a bad reflection on a program and may jeopardize a program's current and future funding. To minimize this risk, the Program Management Office prepares a spending plan that projects and tracks obligations and expenditures on a month-by-month basis.

A spending plan is required for each Procurement line item, RDT&E program element, and Operations and Maintenance sub-activity group in the program. The PMO creates an obligation plan for each fiscal year of funding that is available for new obligations and an expenditure plan for each fiscal year of funding that has not been completely expended, even if the period of obligation availability has expired.

Spending plans serve as a tool to analyze program execution, an indicator of potential problems, and a predictor of future program performance. Generally, a history of poor obligation, expenditure, or outlay will cause a program to come under increased scrutiny or - worse - to lose funding. When a program deviates from its spending plan, it risks becoming a source of funding for other programs through reprogramming and runs the risk of having its funding cut in future years.

Version 1.0 (11 July 2014)

Lesson Summary

Operational and Live Fire Tests

The following learning objectives are covered in this lesson:

- Identify which organizations develop, coordinate, or approve Critical Operational Issues (COIs).
- Identify which organizations develop, coordinate, or approve Critical Technical Parameters (CTPs).
- Recognize how Measures of Effectiveness (MOE) and Measures of Suitability (MOS) are used throughout the Test and Evaluation (T&E) process.
- Recognize the purpose and objectives of Live Fire Test and Evaluation.
- Distinguish among various types of Developmental Test and Evaluation (DT&E) (e.g., Production Qualification Tests, Production Acceptance Test and Evaluation, etc.).

Initial Operational Test and Evaluation

Developmental test and evaluation is essential in determining a system's readiness for initial operational test and evaluation (IOT&E). The results of developmental testing are formally reviewed in an Operational Test Readiness Review (OTRR) prior to proceeding with IOT&E.

Critical Technical Parameters

Critical Technical Parameters (CTPs) are key parameters and developmental testing criteria that are derived from Warfighter capabilities specified in the Capability Development Document (CDD) / Capability Production Document (CPD), and from technical performance measures as specified by the System Engineering Plan (SEP). The CTPs are developed, coordinated and approved by the T&E Integrated Product Team (IPT) within the Program Management Office. Examples of CTPs are an aircraft's engine thrust, cruising speed, range and altitude. CTPs are measurable criteria that, if not achieved during DT&E, preclude fulfillment of desired operational performance capabilities.

Developmental Testing

Two types of developmental testing become important as a system nears and enters production.

Production Qualification Testing

Production Qualification Testing (PQT) is conducted on a small number of initial production items to evaluate the effectiveness of the manufacturing process.

Production Acceptance Testing and Evaluation

Production Acceptance Testing and Evaluation (PAT&E) is conducted on items as a form of quality assurance to ensure that contractual obligations are being met.

Operational Test and Evaluation

Operational test and evaluation is conducted to determine if a system will successfully meet the user's capability needs.

Critical Operational Issues

Critical Operational Issues (COIs) indicate the operational effectiveness and operational suitability needs of a system. They are expressed in the form of a question, developed by an independent operational test agency, and broken down into quantifiable MOEs and MOSs. An example of a COI is: "Does the aircraft accomplish its mission in the battlefield environment?"

Measures of Effectiveness

Measures of Effectiveness (MOEs) are specific, objective measures of system performance that are closely related to mission accomplishment. An example of a MOE is: "Number of targets destroyed".

Measures of Suitability

Measures of Suitability (MOSs) are specific, objective measures of how well as system can be maintained and utilized by the end user. They are written and approved by an independent operational test agency. An example of a MOS is: "Aircraft Mean Time Between Failure (MTBF)."

In summary, COIs are the primary operational issues that must be answered by the testing program, while MOEs and MOSs may be thought of as the quantifiable measures that can be used to determine whether the COIs have been addressed successfully. In turn, CTPs provide developmental test data that help support the MOEs and MOSs.

Live Fire Test and Evaluation

Live Fire Test and Evaluation is required by law for certain major systems before full-rate production can begin:

Survivability testing is required for "covered" systems that are occupied by personnel and designed to provide the personnel some degree of protection in combat situations.

Lethality testing is required for all major munitions and missile programs to determine whether the weapon can reliably disable or destroy its target.

Live Fire Test and Evaluation results are sent to the Director, Operational Test and Evaluation (DOT&E), acting as the OSD agent, who then reports them to Congress before a program can move forward beyond Low-Rate Initial Production (LRIP) and on to full-rate production.

Version 1.2 (31 December 2015)

Lesson Summary

Best Manufacturing Practices

Learning Objectives

The following learning objectives are covered in this lesson:

- Recognize the value of Lean Manufacturing.
- Identify methods of controlling manufacturing costs (e.g., process proofing, variability reduction, and statistical process control).
- Distinguish between process and product structures.

Lean Manufacturing

Two main principles of lean manufacturing are **minimization of waste** and **responsiveness to change**. By practicing lean manufacturing techniques, the contractor can control costs and more effectively meet customer requirements.

- Waste can manifest itself in many forms, including:
- Inefficient layouts
- Defective equipment
- Excess inventory
- Inefficient production or assembly processes

By reducing the time needed to adjust or react to changes taking place, whether in the product or a process, the contractor can reduce waste associated with these changes. To do so effectively requires buy-in from everyone, from top management all the way to employees on the factory floor. Some characteristics of organizations that have lean manufacturing processes include:

- Team-based approach
- Minimal inventory
- Customer-driven products and inventory quantities
- Concurrent product and process design
- Multi-skilled workforce

Reducing Costs

Manufacturing costs can be reduced utilizing a variety of tools, including:

- **Process proofing**: By examining and verifying the production process and support infrastructure, early production problems can be eliminated.
- **Variability reduction**: Common cause variability, which is inherent in the production process, is typically corrected by management. Special cause variability, as its name implies, is triggered by a unique event and is often corrected at the worker level. Reducing variability improves product cost, quality, and reliability.

- **Statistical process control**: Involves using statistical analysis to track and measure variability. By using SPC, the contractor can pinpoint causes of variability early, then eliminate them, thus reducing costs and improving performance.

Optimal Process

For every given product, there is an optimal process structure that can be used to produce it. In order to determine the process, the product type must be identified first. Products can be classified using a continuum of product standardization and production volume. Production for highly standardized and high volumes of products, such as bullets, require a different process than one of a kind products, such as satellites. These product types are at the opposite ends of a continuum.

A process can be identified using a continuum of production flow that ranges from high, or continuous flow, to low, or jumbled flow. One of a kind items fit under a jumbled flow, where specialized material and flexible methods are required. On the opposite end of the continuum, high volumes of products require a continuous flow, where interchangeable parts and standardization of assemblies are required. What resources and procedures the contractor needs to most effectively produce a product should define the process structure.

Version 1.0 (11 July 2014)

Lesson Summary

Unauthorized Commitments

Learning Objectives

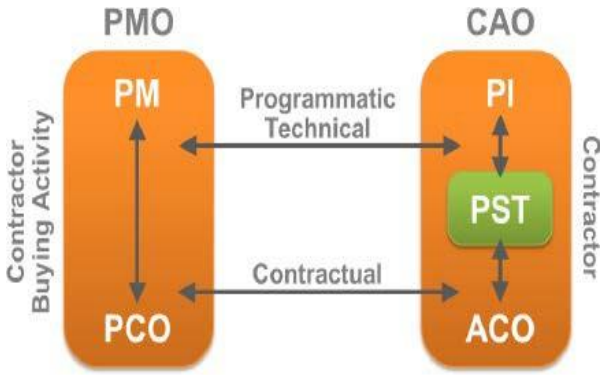
The following learning objectives are covered in this lesson:

- Identify the relationship between the Program Management Office, the Procuring Contracting Officer, the Administrative Contractor Officer, and Program Integrator.
- Identify the causes and consequences of unauthorized commitments.

ACO, CAO, PCO, and PI

The Administrative Contracting Officer (ACO) works for the Contract Administration Office (CAO) under the head of the Defense Contract Management Agency. The primary responsibility of the ACO, as delegated by the Procuring Contracting Officer (PCO), is contract administration, including:

- Contractor payment
- Administrative Contract modification
- Program technical support
- Quality assurance
- Property management
- Engineering and production surveillance



The primary responsibility of the ACO is overseeing the day-to-day contractual activities after contract award has been made and ensuring that the contractor satisfies the terms and conditions of the contract. As such, the ACO has a direct line of communication with the Procuring Contracting Officer (PCO).

The Program Integrator (PI), who also works for the CAO, provides support for the Program Management Office. The PI's duties are defined by the PM and written into the Memorandum of Agreement, which is then signed by the PMO and CAO. It is essential to the PI's job that he or she keeps in direct communication with the PM. The PI:

- Acts as the "eyes and ears" of the PM
- Leads and directs the program support team (PST)
- Provides feedback and data to the PM
- Develops and implements program surveillance plans

Unauthorized Commitment

A **Constructive Change** is an oral or written act (or failure to act) by an authorized Government official in a *position of authority* construed by the contractor as having the same effect as a written change order (on an existing contract). It usually occurs when the contract work has been changed but proper procedures

have not been followed (i.e. when a Government official, other than the Contracting Officer, interacts with the contractor). However, a Contracting Officer acting outside his/her authority can effect a constructive change.

Any **unauthorized** change that requires the contractor to perform beyond the requirements of the contract can lead to unauthorized commitments. The only person authorized to make changes to a contract is the Contracting Officer (CO). Occasionally a government employee will initiate a change believing that he or she is empowered to do so. Sometimes the contractor makes these changes under the assumption of apparent authority--that someone's rank, title, or tenure authorizes that person to make changes. Rank, title, or other indicators do not equal lawful contracting authority! Only the CO has the authority to initiate and approve contract changes.

An **Unauthorized Commitment** is an agreement that is not binding solely because the Government representative who made it *lacked the authority* to enter into that agreement on behalf of the government (for an existing contract or no contract).

Other situations that can lead to constructive changes include:

- Technical terms that are "impossible to perform"
- The acceleration of work or performance despite a contractor's valid claim of an excusable delay
- Government inspection that exceeds any reasonable interpretation of what a contract may require
- Government failure to disclose its superior knowledge when such knowledge is essential to the performance of required work
- Unauthorized technical direction by Government personnel

In extreme situations, a person who initiates an unauthorized commitment can be held personally liable for the costs associated with this mistake. In this situation, the liability is determined by each respective agency on a case-by-case basis.

Version 1.0 (11 July 2014)

Lesson Summary

Production and Follow-On Support

Learning Objectives

The following learning objectives are covered in this lesson:

- Recognize the value of the Cost of Quality.
- Identify where and when learning curve theory is applied.
- Recognize the impact of manufacturing on cost, schedule and performance.
- Recognize the considerations/concerns of the elements of manufacturing (5Ms) and how other areas are affected.

Five Elements

The **five elements of manufacturing**--manpower, machinery, materials, methods, and measurement--all contribute to the cost of production. The cost of producing a quality end product will vary depending upon how that quality is achieved. By putting processes in place to prevent problems in the first place, less money will be spent on correcting and rework of failures.

The cost of achieving quality can be broken down into three areas: prevention, appraisal and failure.

- **Prevention** - money spent on avoiding problems, such as utilizing process proofing. Ideally, prevention should make up about 50% of the cost of achieving quality.
- **Appraisal** - money spent looking for errors through testing and inspection. Appraisal costs should make up about 35% of the cost of achieving quality.
- **Failure** - money spent correcting errors, often in the form of rework or repair. Correcting failures should only account for about 15% of the total cost of achieving quality.

Although more money may be spent to avoid costs up front, less money will be spent on production in the long run.

Learning Curve

Learning curve theory states that as the production of an item doubles, the man-hours needed to produce that item decrease at a fixed rate. In other words, the more items that are produced, the less it should cost per item. Declining unit costs are a result of workers becoming more familiar with their tasks and making process improvements based on their experience.

Learning curve theory is most applicable in situations where the following conditions exist:

- Uninterrupted serial production
- Consistent product design
- Management emphasis on productivity improvement

Plotting this reduction in cost onto a graph results in a curved line. If, for example, the cost has been reduced by 20%, then there is an 80% learning curve. Thus, an 80% learning curve means that the cost of a particular unit of production is 80% of the cost of the unit exactly halfway back in the production sequence. The steeper the learning curve, the greater its impact.

Factors that influence the learning curve include:

- Manufacturing methods and processes
- Item complexity
- Workforce stability
- Production breaks

Version 1.0 (11 July 2014)

Lesson Summary

Contract Modification

Learning Objectives

The following learning objectives are covered in this lesson:

- Contrast a Change Order with a Supplemental Agreement.
- Identify how instability of requirements, design, and production processes impact program cost and schedule.
- Identify the proper DoD Appropriation Category to be used for each of the phases of a Product Improvement Program.

Unstable Requirements

Requirements that are not stable can become very expensive, impacting schedule and cost because of a "ripple effect" through the system's entire configuration. Changing requirements late in the acquisition process often requires re-design, re-fabrication, and re-testing of many system components. Usually, the later the changes are made in the life cycle, the more expensive they are. Therefore, system requirements should be stabilized well before production begins.

Acceptable Ways to Change a Contract

Undefinitized contract action means any contract action for which the contract terms, specifications, or price are not fully agreed upon before performance is begun under the action. Examples are letter contracts, orders under basic ordering agreements, and provisioned item orders, for which the price has not been agreed upon before performance has begun.

Definitization means the agreement on, or determination of, contract terms, specifications, and price, which converts the undefinitized contract action to a definitive contract.

A Change Order and a Supplemental Agreement are two acceptable ways to change an existing contract.

Change Orders

Government contracts contain a changes clause that permits the contracting officer to make unilateral changes in certain areas that are within the scope of the contract. Those areas are: drawings, designs and specification for supplies specifically produced for the government; method of shipment or packing of supplies; place of delivery.

The use of **Change Orders** are limited because there may be an impact to the contract terms and conditions or cost that goes beyond the change which is not known when the change order is issued. It is typically used when time is of the essence. If the contractor determines that the change has affected the terms of the contract, including price, a request for equitable adjustment (REA) may be submitted within 30 days to the contracting officer. To issue a change order, the contracting officer needs to have direction from the PM detailing the needed changes and certified funds to cover anticipated costs, if applicable.

The notional change order process is as follows:

1. Program Manager (PM) directs change
2. Details of change are identified (to include available funding
3. Issue change order (with not-to-exceed amount)
4. Contractor submits REA (if applicable)
5. Negotiate REA and sign Supplemental Agreement

Supplemental Agreements

A **Supplemental Agreement** is a bilateral agreement, signed by both parties, on what will be changed and at what price. Under a Supplemental Agreement, a price for the work to be done is negotiated before the work actually begins. This is the more preferred method, as long as there is enough time to reach an agreement before the work begins.

The supplemental agreement process is as follows:

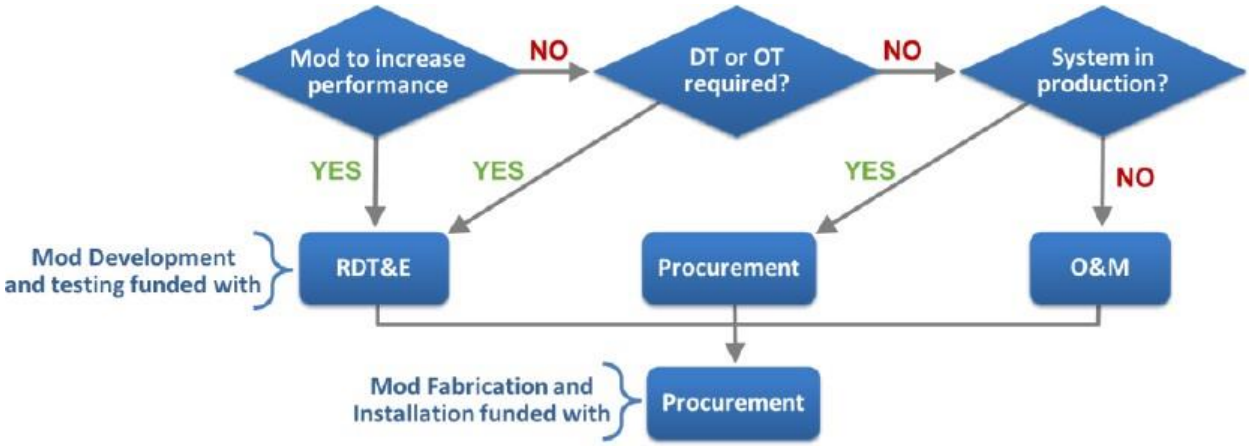
1. Government issues modified SOW or SOO
2. Contractor submits change proposal
3. Government evaluates and audits proposal
4. Government and contractor prepare negotiations
5. Government and contractor conduct negotiations
6. Government modifies contract
7. Government and contractor review and sign contract

Product or System Modifications

If any product or system modifications need to take place, funding must be used from the correct appropriation category. The type of funds used for development and testing of the modification is directly related to:

- The purpose of the modification;
- Whether or not extensive developmental or operational testing is required; and
- Where the system is in the life cycle
- If a modification increases the system's performance capability, or if the testing will be done by an independent government agency, funding for development and testing should come from RDT&E appropriations.
- If the modification does not increase system performance and the system is still in production, procurement appropriations should be used to fund research, development, and testing of the mod.
- If the modification does not increase system performance, and if the system is no longer in production, then Operations and Maintenance appropriations should be used to fund research, development and testing of the mod.

Regardless of which appropriation is used to develop and test the mod, the fabrication and installation of mod kits should be funded with procurement appropriations.



A modification is not considered to increase the performance capability if it only extends the system's years of usefulness. Likewise, improvements in maintainability or reliability are not considered to increase system performance for the purposes of funding.

Version 1.1 (30 June 2015)

Lesson Summary

Contract Dispute

Learning Objectives

The following learning objectives are covered in this lesson:

- Contrast the difference between termination for convenience, termination for default, and termination for cause.
- Identify the process for resolving disputes between parties of a contract.
- Given a funding shortfall, apply the rules governing the use of expired funds to resolve the problem.

Contract Terminations

Contract termination can occur for two main reasons: convenience or default.

- **Termination for Convenience:** allows the Government the unilateral right to completely or partially terminate a contract if the work no longer needs to be done or there is no more funding available. If a contract is terminated for convenience, the government must reimburse the contractor for the cost of completed work, a reasonable profit for that work, and costs associated with termination settlement.
- **Termination for Default**: allows the Government to completely or partially terminate a contract for *non-commercial* items because the contractor fails to deliver on time, endangers a timely delivery, or fails to comply with the terms or conditions of the contract. In this case, the government is only responsible for paying for products delivered and accepted. The government is also entitled to reimbursement for expenses incurred as a result of finding another contractor.
- **Termination for Cause**: A type of termination for default that applies only to contracts using commercial item procurement procedures. Termination for cause allows the Government to completely or partially terminate a contract for *commercial* items because the contractor fails to deliver on time, endangers a timely delivery, or fails to comply with the terms or conditions of the contract.

Contract Dispute Resolution

There are two options for resolving contract disputes: Litigation and Alternative Dispute Resolution. Both parties of a contract can exercise these options. Disputes between the government and contractor can be very costly for both parties, especially if the dispute results in litigation. Alternative Dispute Resolution uses selected methods to resolve disputes without going to court, including the following:

- **Mediation**: A neutral third party listens to the issues, helps develop options, and works with the disputing parties to obtain a negotiated settlement. Mediation helps preserve relationships. The parties in the dispute maintain high level of control over the outcome.
- **Fact-finding**: A neutral technical expert renders an advisory decision to both parties based on the facts presented by the disputing parties.

- **Mini-Trial**: Senior-level management listens to both parties and renders a decision. A neutral third party can help in clarifying and identifying issues, but senior management is ultimately responsible for negotiating a settlement.
- **Non-binding Arbitration**: A neutral third party renders a non-binding decision based on evidence presented by disputing parties. Arbitration is closest to litigation.
- The purpose of ADR is to resolve disputes in an environment that is collaborative, not competitive. Alternative Dispute Resolution (ADR) should be the first resort to solve disputes when appropriate, but there are circumstances where taking the dispute directly to court is necessary. Court is most appropriate when:
    - Dispute is over issues of law
    - Full public record is required
    - Fraud is suspected
    - Other party is likely to falsely present their case

Expired Funds

Funds are considered "expired" when the obligation period for that fund has expired. For example, RDT&E funds have a two-year obligation period. After this two-year obligation period is over, RDT&E funds are available for expenditure for five more years but are considered expired. Expired funds still retain their original appropriation category, year, line item and other accounting identifiers for the expenditure time beyond the original obligation period. Expired funds can only be used for payment or adjustments to the original obligations during the expired period and cannot be re-assigned to new obligations.

Lesson Summary

Life Cycle Product Support

Learning Objectives

The following learning objectives are covered in this lesson:

- Identify life cycle product support activities and requirements that deal with fielding/deployment (e.g., planning, coordination, organizing deployment teams, materiel release).
- Identify life cycle product support activities and requirements associated with post-production support (e.g., planning, adequate sources of supply, spares modernization and sustaining system readiness).
- Identify system supportability issues in planning and executing a defense acquisition program.
- Determine the impacts to a given acquisition program if supportability issues are not resolved.

Deployment Planning

The primary purpose of deployment planning is to ensure a smooth introduction of the system to the end user. Deployment planning must take into account all of the parties involved in this process by specifically defining responsibilities of each. Thus, successful system deployment is directly related to how well deployment is planned, coordinated, negotiated and executed.

Deployment Planning usually begins in the Materiel Solution Analysis Phase, where a deployment team drafts a deployment plan that is incorporated into the Life Cycle Sustainment Plan. To enable the system to move smoothly from production to operation, all related support activities must be well coordinated, requiring effective lines of communication. Some examples of these support activities include:

- availability of training manuals and accurate technical data
- manpower to operate and support the system
- adequate supply support
- facilities & infrastructure support
- packaging, handling, storage and transportation

Good deployment planning also defines how system modifications might be tracked, determines how training will be developed and implemented, and ensures the availability of spare parts, for example. Overlooking these elements will lead to poor training, personnel turnover, continual system modifications, and technical problems such as software anomalies - all of which will impede a smooth introduction of the system and can potentially drive up the life cycle costs.

Additionally, deployment planning involves efforts to reduce the "footprint" of the system. Footprint reduction includes **minimizing** the amount of supporting material (including parts inventory and special tools), equipment and maintenance personnel required when forces are deployed, all of which are intended to help drive down life cycle costs.

Supportability

Integrated Product Support (IPS) Elements

Supportability concepts define the overall logistics end state in achieving product support. The PM and the Product Support Manager (PSM) develop logistics support concepts (e.g., organic, two-level, three-level, contractor, partnering, etc.) early in the program, and refine the concepts throughout program development. Using the IPS elements, support concepts for all systems should be structured to provide cost effective, total life cycle logistics support. Every acquisition program, regardless of size, must plan for 12 Integrated Product Support Elements:

1. Product Support Management
2. Design Interface
3. Sustaining Engineering
4. Supply Support
5. Maintenance Planning & Management
6. Packaging, Handling, Storage, and Transportation (PHS&T)
7. Technical Data
8. Support Equipment
9. Training and Training Support
10. Manpower and Personnel
11. Facilities & Infrastructure
12. Computer Resources

Life Cycle Cost

Life cycle cost (LCC) includes the cost to develop, acquire, maintain, and dispose of a weapon system over its entire life. LCC includes system:

- Research, development, test, and evaluation
- Investment (procurement, military construction (facilities))
- Operations and support (personnel, spares, support equipment, etc.)
- Disposal

Supportability Goals

The goal of supportability is to increase system capability while:

- Reducing ownership costs
- Reducing dependence on spares
- Requiring fewer support personnel
- Reducing the overall logistics footprint

Sustainment

One important aspect of good deployment planning is Sustainment, which includes delivery of required IPS elements after the system is fielded that contribute to operational readiness. Whereas sustainment used to fall to the Service's sustainment community, the Program Manager is now accountable for "cradle to grave" support, from development and production all the way to disposal. Although the PM has Total Life Cycle Systems Management responsibility, this is often done in conjunction with the contractor, Service materiel and sustainment commands and the Defense Logistics Agency (DLA).

Effective sustainment means minimizing problems up front, which requires a long-term outlook. Current DoD policy that supports effective sustainment includes:

1. The PM is the single point of accountability:
    - Each PM is charged with the accomplishment of program's cost, schedule, and performance objectives for the total life cycle, including sustainment.
2. Evolutionary acquisition:
    - This is DoD's preferred strategy for satisfying operational needs by the rapid acquisition of mature technology. An evolutionary approach delivers capability in increments, recognizing, up front, the need for future capability improvements.
3. Supportability and Sustainment as key elements of performance:
    - Supportability and sustainment are essential components of battlefield effectiveness and must be planned and implemented as early as possible in the life of a program. If a weapon system is not supportable and sustainable, it cannot be considered as an effective warfighting capability.
4. Performance-Based Logistics:
    - PMs shall develop and implement performance based logistics (PBL) strategies that optimize total system availability while minimizing cost and logistics footprint.
5. Performance-Based Life-Cycle Product Support:
    - The PM will develop and implement an affordable and effective performance-based product support strategy. The product support strategy will be the basis for all sustainment efforts and lead to a product support package to achieve and sustain warfighter requirements.
6. Increased reliability and reduced logistics footprint:
    - PMs must ensure the application of a robust systems engineering process to provide for reliable systems with reduced logistics footprint and reduced total ownership cost (TOC).
7. Continuing reviews of sustainment strategies:
    - Reviews must be conducted at defined intervals throughout the life cycle to identify needed revisions and corrections, and to allow for timely improvements in these strategies to meet performance requirements.

Even with effective sustainment, problems can pop up in many areas throughout the system, including depletion of supply lines, system down-time due to a defective part, or ineffective training. All of these problems affect readiness and will lead to poor operational availability. Resolving these issues after the system has been deployed can result in increased life cycle costs. However, most of these problems and the associated costs can be minimized through early and effective sustainment and deployment planning.

Lesson Summary

Leadership and Ethics

Learning Objectives

The following learning objectives are covered in this lesson:

- Identify core ethical values critical to decision making in the acquisition environment.
- Discover how different leadership styles impact the effectiveness of an Integrated Product Team (IPT).

Ethics

Ethics may be thought of as a set of behavioral standards for a group of people or society. Ethics can also be defined as standards of conduct that shape one's behavior with respect to moral duties and obligations. The extent to which a person fulfills those obligations is based on two aspects:

- Ability to distinguish right from wrong
- Level of commitment to doing what is right

Although ethical norms vary from organization to organization, and culture to culture, there are some core values that have been identified by leaders in education, business, religion and government. These include:

- Trustworthiness
- Respect
- Responsibility
- Justice and Fairness
- Caring
- Civic Virtue and Citizenship

Principled Decision-Making

Sometimes defense acquisition personnel encounter ethical dilemmas. Guidance for resolving those dilemmas can be found in a number of classical models. The Golden Rule—do unto others as you would have them do unto you—is simple and timeless advice. Immanuel Kant's belief in the existence of absolute "higher truths" provides a starting point for identifying one's moral obligations. Consequentialism recognizes the complexity of ethics issues and advocates basing decisions upon consequences that yield the greatest good.

The Principled Decision-Making model combines aspects of all three classical models. It calls for decisions to take into consideration the welfare of all stakeholders. It also expects ethical values, such as trustworthiness and fairness, to take precedence over other values, such as efficiency or self-interest. Finally, it offers help in prioritizing conflicting ethical values based on what will bring the most good and the least harm to others.

Leadership Styles

Integrated Product Teams are an important part of the acquisition process, and effective leadership of those teams is essential to their success. There are three primary types of leadership styles found in today's workplace:

- **Supervisory-style:** Typical in line-level supervision, this leadership style is characterized by directing individual workers, providing them with one-on-one training, and resolving conflicts. These leaders most often react to change, rather than initiate it.
- **Participative-style:** Effective in an IPT environment, this leadership style involves getting multiple inputs prior to making decisions, developing team member performance, coordinating group efforts, and implementing productive change.
- **Team leadership-style:** Highly effective in an IPT environment, leaders with this style create team identity and maximize a group's performance by capitalizing on the diversity of its members. These leaders foresee and influence change to constantly expand the team's capabilities.

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