



# Affordability Analysis: How Do We Do It?

**1 -4 October 2012 | Lockheed Martin  
Corporation, Arlington, VA**

**Workshop Report**

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## Final Report – Revision 6

By Kirk Michealson, Workshop Chair

### EXECUTIVE SUMMARY

Given the current budget crisis and the complex and uncertain security environment, the Department of Defense is very focused on affordability. The previous Under Secretary of Defense for Acquisition Technology & Logistics (USD/ATL) has defined affordability as “cost effective capability.” However, in discussions at the October 2011 MORS Special Meeting on Risk, Trade Space, and Analytics in Acquisition, the Development Planning Working Group discovered that affordability analysis was ill-defined. The working group recommended developing and formalizing affordability analysis processes, including recognizing the difference between cost and affordability analyses.

To kick-off this endeavor, MORS held a workshop on Affordability Analysis: How Do We Do It? at Lockheed Martin’s Global Vision Center in Arlington, VA on 1-4 October 2012. The purpose of this meeting was to provide a forum for discussing approaches to affordability analyses, including methodologies, historical perspectives and recent innovations in order to new insights and approaches.

The consensus of the working groups was that clarity of definition, sufficiency criteria, and regulatory policy are consistently absent from affordability analysis. Affordability is not a number, but a decision, and may vary depending on the stakeholder or the decision maker. When one conducts cost or cost-benefit analysis, the process is straightforward; analysts follow established guidelines and principles. However, when conducting affordability analysis, responses vary dramatically.

During the workshop, the working groups were asked to discuss the difference between affordability analysis and cost analysis. A consistent theme was that cost analysis is a dollar breakdown of the implementation effort, tactical in nature, and tool oriented. In contrast, affordability analysis is strategic in nature; it looks at trade demands, dollars per capability, return on investment; and requires a behavioral change in culture. Affordability analysis is

- The analysis of a portfolio to identify best mix of capabilities to achieve the mission at least cost
- The analysis of a system to minimize the cost of achieving the desired capability over the full life cycle





Affordability is inseparable from prioritization. Because affordability is more of a concept than a firm number such as cost, “things” are only affordable if they are higher priority than things that are unaffordable. Affordability analysis illuminates what is achievable within a portfolio. The portfolio, however it is defined, is relevant and must be thoroughly examined to ensure that decisions are made with respect to the appropriate offsets. Affordability analysis considers what DoD can afford to forego (i.e., assessment of risk): it is a matter of comparison. Decision-makers’ acceptance that something is affordable implies that they have agreed that something else is unaffordable.

Affordability analysis occurs at many levels. Each level provides a specific context and set of assumptions, constraints and procedures. The level determines the scope of the analysis, as well as the actors and decision makers involved. There are numerous aspects associated with the concept of affordability analysis and more specifically with the concept of the associated trade space. These need to be distinctly clarified any time affordability analysis is being conducted. A consistent view of portfolios should be developed.

The process, methods, and, most importantly, the data needed to conduct effective affordability analysis are not available. Our process for budgeting and procurement focuses on the Future Years Defense Plan (FYDP) and procurement costs, not on the life cycle. In the Development Planning phases, decision makers can be blind to affordability issues that are beyond the FYDP. The most significant costs and affordability challenge in the early lifecycle lie beyond the FYDP. Affordability analysis must be conducted using the full range of costs. Part of this affordability process and infrastructure is the program authority, responsibility, and accountability. These are currently fragmented across the life cycle of a system (concept exploration to disposal), spread across different phases of the life cycle, and spread across various organizations and people. The results are that decisions are made without full accounting of true and complete costs.

For the state of practice for affordability analyses, the consensus across the working groups was that it was weak, although there are pockets of successful affordability efforts. Looking across the three classic areas of Process, People and Tools, a stoplight chart was created by one working group. The Processes would be RED (broken or nonexistent / not formalized), People as YELLOW (some shrinkage of the analytic base occurring and the need for the combination of analytic capability and acquisition knowledge / experience), and Tools as GREEN (sufficient tools available).

Another point the working groups discussed was what was needed from the operations analyst to conduct affordability analysis. The attendees agreed that analysts need a good understanding of what affordability analysis really is and the associated deliverables. The recommended knowledge needed for affordability analysis is a basic Operations Research / System Analyst (ORSA) skill-set plus understanding of the acquisition process and decision analysis skills in order to analyze comparative choices.

The MORS Affordability Analysis Workshop was timely, providing needed discussions from key leadership, organizations, and individuals. However, the matter should not end here. A small core group, perhaps the core of a new MORS Affordability Analysis Community of Practice, could be established to continue working with the government on the workshop recommendations discussed in this final report.



## **SPECIAL MEETING SUMMARY**

### **BACKGROUND**

Given the current budget crisis and the complex and uncertain security environment, the Department of Defense is very focused on affordability. The previous Under Secretary of Defense for Acquisition Technology & Logistics (USD/ATL) has defined affordability as “cost effective capability.” However, in discussions at the October 2011 MORS Special Meeting on *Risk, Trade Space, and Analytics in Acquisition*, the Development Planning Working Group discovered that affordability analysis was ill-defined. The working group recommended developing and formalizing affordability analysis processes, including recognizing the difference between cost and affordability analyses.

Additionally, the National Defense Industrial Association Systems Engineering (NDIA SE) Division and the Industrial Council of Systems Engineering (INCOSE) have both established Affordability Working Groups. They have spent time determining what affordability is and how it relates to government and industry, but they have not considered the rationale behind making affordability-related decisions – i.e., the analysis necessary to make these decisions. As a result, these two sister societies approached MORS to work together to define affordability analysis.

To kick-off this endeavor, MORS held a workshop on *Affordability Analysis: How Do We Do It?* at Lockheed Martin’s Global Vision Center in Arlington, VA on 1-4 October 2012. The goals of this meeting were to:

- Provide a forum for discussing Army, Navy, Marine Corps, Air Force, Office of the Secretary of Defense, and Joint Staff approaches to affordability analyses throughout the life cycle.
- Provide an opportunity for operators, engineers, decision makers, academicians, and military and civilian operations research analysts to examine topics, methodologies, analyses, and innovations pertinent to all aspects of analysis for affordability as a function of total ownership cost and system performance.
- Balance a “voyage of discovery” without “distracting from the work already completed,” i.e., to move forward in the area of affordability analysis.

### **INDUSTRY MARKETING PARTNERS**

This was also the first MORS Special Meeting which planned and executed a workshop with industry marketing partners. The NDIA SE and INCOSE Affordability Working Groups (WGs) had already approached MORS and were the first two industry marketing partners. Since we were going to discuss the relationship between cost analysis and affordability analysis, representatives from the Society for Cost Estimating and Analysis (SCEA) were invited. Additionally, MORS always looks for opportunities for joint meetings with its sister society INFORMS MAS (the Institute for Operations Research and Management Sciences, Military Applications Society (MAS). These four industry marketing partners advertised the MORS Workshop to their membership and provided representatives to the planning committee and actual workshop.



Promoting National Security Since 1919





**Figure 1 – Industry Marketing Partner Logos**

In addition to the Industry Marketing Partners, a government-led working group – the Acquisition Modeling & Simulation Working Group – supported the workshop by providing a link to the MORS Workshop on their website and encouraging members to participate in the working groups.

## PARTICIPANTS

As shown in Table 1, 154 analysts and decision-makers participated. Of these, 51 were members and 103 were non-members. There was good representation overall from across government and industry, including 5 foreign personnel from Canada, Israel and the United Kingdom.

GOVERNMENT			INDUSTRY			ACADEMIA		
Organization	#	%	Organization	#	%	Organization	#	%
OSD	11	19.0%	Boeing	7	10.1%	ALU	2	16.7%
Joint Staff	4	6.9%	Lockheed Martin	31	44.9%	DAU	1	8.3%
Army	18	31.0%	Northrop Grumman	4	5.8%	JHU/APL	6	50.0%
Air Force	9	15.5%	Raytheon	5	7.2%	NPS	1	8.3%
Navy	2	3.4%	Other	18	26.1%	Stevens	1	8.3%
Marine Corps	7	12.1%	Consultant	4	5.8%	USC	1	8.3%
NASA	2	3.4%	<b>TOTAL -</b>	<b>69</b>	<b>44.8%</b>	<b>TOTAL -</b>	<b>12</b>	<b>7.8%</b>
Other	5	8.6%	FFRDC			FOREIGN NATIONALS		
<b>TOTAL -</b>	<b>58</b>	<b>37.7%</b>	Organization	#	%	Organization	#	%
Workshop			IDA	8	80.0%	Canada	3	60.0%
<b>TOTAL -</b>	<b>154</b>		MITRE	2	20.0%	Israel	1	20.0%
			<b>TOTAL -</b>	<b>10</b>	<b>6.5%</b>	UK	1	20.0%
						<b>TOTAL -</b>	<b>5</b>	<b>3.2%</b>

NOTE: Total Percentages are the organization percentages of the workshop total number (154), while organization percentages are percentages within the group (e.g., government, industry, academia, FFRDC & Foreign)

**Table 1 – MORS Affordability Analysis Workshop Participants**



## KEY QUESTIONS

The key questions from the MORS Affordability Analysis Workshop were:

- What is affordability analysis?
- How is it different from cost-benefit / cost-effectiveness analyses?
  
- What is the state of the practice of affordability analyses?
  - What is needed to conduct affordability analyses?
  - What is the preferred approach for incorporating the systems full life cycle in affordability analyses?
  - How should we measure the affordability of a force structure in a mission context?
- What are some examples of how analytical rigor has been applied to support affordability analyses?
- What are the major future challenges?

Highlights of the workshop discussion on these questions will be provided in the remainder of this final report.

## WORKSHOP OVERVIEW

### Workshop Kick-Off (Day Before) –

Since there were numerous overall workshop and working group specific objectives to be discussed during the working group sessions, the afternoon of the first day was devoted to providing the attendees a solid foundation of affordability-related background information. The Workshop Kick-off covered four areas: (1) Expectations, (2) Foundation, (3) Background, and (4) Opportunity. For Expectations, each of the working group chairs provided an overview of their group's goals and expectations. Next there were Foundation and Background presentations on the affordability glossary developed for the workshop and on the "Better Buying Power" memos issued by OSD(ATL), respectively.

In preparation for the workshop, a glossary was created for each working group and synthesis group to have a common foundation for discussions. With the number of overarching workshop and specific working group objectives, there was not any time during the actual workshop to develop definitions. In developing the definitions, the following philosophy was followed: (1) determining reasonable definitions the working groups could use and work with during the workshop; (2) looking for consensus, not 100% agreement, and (3) striving for simplicity, not detailed definitions. The glossary was provided in the read aheads on the MORS Affordability Analysis Workshop webpage at: <http://www.mors.org/events/2012aa.aspx>. The terms in the glossary include: affordability, affordability analysis (pre-workshop), capital budgeting (portfolio analysis), cost analysis, cost benefit analysis, cost effectiveness analysis, life cycle costs, risk, should cost and total ownership costs.

The origins of the Better Buying Power (BBP) Memorandum were some efficiency initiatives that evolved into a panel of Flag Officer / General Officer equivalents who considered hundreds of best practices, past analyses, and other information. Their final list had 23 initiatives in five distinct thrusts. This is not just another Acquisition Reform initiative—the primary goals are to (1) Improve productivity of the Defense enterprise; (2) Restore affordability to Defense goods and services; and (3) Deliver the warfighter capability DoD needs with the dollars we have now and will have in the



future. Additional goals include removing government impediments and non-productive processes; maintaining a healthy and vibrant Defense industry; improving both the acquisition workforce and associated trade/craft.

The BBP initiatives expand on the DoDI 5000.02 definition of affordability. Now affordability means not only to stay within budget, but also to be able to buy increasing levels of capability within an almost static budget. In Dr. Carter's words: "DO MORE WITHOUT MORE." The five affordability initiative thrusts seek to reduce non-value added overhead in programs and devote the savings to procuring increased capability for our warfighters. The affordability initiatives seek to do this by (1) implementing affordability requirements at milestone reviews, (2) imposing affordability constraints on new starts, (3) making affordability analysis a part of the DAB planning process, and (4) introducing these requirements into programs further along in development/production. Some key themes include setting an affordability target early in the programming and tracking it; using the standard sand chart techniques, but doing so over time; and closely monitoring growth, with an eye toward growth causes such as requirements creep examples of affordability and better buying power: Ohio Class Sub cost was reduced from \$7.4B to \$4.9B and the Ground Combat Vehicle development was reduced from 10 years to 7 years at Milestone A.

The workshop kick-off ended with an Affordability Thinking session to get all the attendees ready for the next three days. A mini workshop was conducted to promote and encourage an out of the box approach to the main Affordability Analysis Workshop. Affordability Thinking is a Lockheed Martin initiative to enhance the cost consciousness of its engineering and programmatic workforce. It attempts to address the complexity of Affordability by providing approaches at reframing and offering up multiple perspectives on the problem and encouraged spirited and opposing viewpoints. The workshop also uses the Cynefin Framework of problem classification to illustrate the effects of oversimplification or over complication of problems and either could drive ineffective or inefficient action. Participants found the exercise beneficial.

In this interactive session, the attendees participated in breakout session to discuss three major points:

- Defining / bounding the problem – what is the relationship between cause & effect?
- Reframing the problem with a multi-disciplinary team, and
- Determining the healthy tension among cost, performance, schedule and risk.

### **Plenary Session (1<sup>st</sup> Day, AM) –**

The plenary session in the morning of the first day featured presentations from senior leadership to provide their perspective of affordability and affordability analyses. The welcome and introductions were presented by the MORS President (Mr. Michael Garrambone, InfoSciTex Corporation) and Workshop Overview by the Workshop Chair (Mr. Kirk Michealson, Lockheed Martin). After the greetings and overview, there were two keynote presentations (1) the Government Keynote & Proponent Welcome by Ms. Katrina G. McFarland, Assistant Secretary of Defense for Acquisition, and (2) the Industry Keynote & Host Welcome by Dr. Ray O Johnson, Senior Vice President and Chief Technology Officer, Lockheed Martin Corporation.



The Honorable Ms. McFarland kicked off the Affordability Analysis Workshop with a keynote address rich with insights from her government career in engineering, acquisition and program management. The ideas of affordability and controlling costs have been around for many years. The “Design to Cost” book was written in 1980 and is still relevant today. Affordability is the common thread and the systems analysis and design stages should include early consideration of all aspects of the emerging program. One key area is the understanding of affordability applications early and continuously during the life of a program. That includes early consideration of Operations & Support (O&S) costs. The requirements process should also set the stage for good affordability analysis. Cost controls and design to cost are important, with consideration of spending to what is well defined, reasonable and affordable. We need to keep in mind what we are trying to achieve – the ultimate capabilities and that the area of cost analysis is a subset of affordability. The requirements process should also set the stage for good affordability analysis. The continuing interaction and information exchange is necessary to reach affordability goals.

Dr. Johnson challenged the workshop audience to practice innovative thinking to tackle affordability issues. He noted that we won the cold war with technology, but we'll overcome cost with innovation rather than addressing it with technical and capability enhancements. He feels our biggest threat is the budget. We have an over-leveraged economy, and we need rigorous innovative thinking applied to cost analysis.

On the National Security side, Dr. Johnson thinks that there is a new reality unlike what we've experienced in the past. That is, facing increasing global security challenges with decreasing resources. These security challenges include China's investments in science, technology, and their business enterprises. Further, we have a destabilized Middle East. Iran's neighbors have indicated that if Iran becomes nuclear, they will pursue nuclear weapons as well. Lastly, protecting computer networks is far greater than trust and assurance. How do we protect the F-35, a flying network, from infecting and being infected by test equipment in Italy?

He noted that our constrained resources are not a result of a tight budget or Sequestration. The problem is our over-leveraged economy and the political will to balance it. How will the analytic community take-on these challenges? How do we analyze affordability across the requirements, initial acquisition, development, production, sustainment spectrum? He believes that innovation is the key. Engineers have been trained to provide exquisite performance. Technology is not what is needed, cost and affordability innovation is what is needed. Analysis will be fundamental to balance performance and affordability.

Next, senior leaders presented their organization’s perspective of affordability and affordability analysis in panel discussions. The Plenary Panel presentations were provided by:

- |   |  |
|---|--|
| • OSD(ATL) Affordability Lead:                | Dr. Phil Anton, OSD(ATL)                                       |
| • Cost Analysis Perspective:                  | Steve Miller, OSD-CAPE   |
| • Analysis of Alternatives (AoA) Perspective: | Dr. Jerry Diaz, AF/A5RP, AF AoA SME                            |
| • J8 JROC/JCIDS/CBA Perspective:              | Brig Gen Scott Stapp, USAF, J8 Deputy Director of Requirements |
| • NDIA SE Affordability WG Perspective:       | Frank Serna, Draper Labs                                       |
| • INCOSE Affordability WG Perspective:        | Joe Bobinis, Lockheed Martin                                   |



Dr. Anton stated that conceptually the acquire decisions are at the OSD level and at the Services. However, the discussions on affordability are primarily worked at the Services and Agencies. He used the example of automobiles to bring home his concept of affordability. If he really wanted an exotic sports car like a Maserati, he might be able to afford it. However, he might have to give up other things such as housing, because the maintenance required (read O&S) would be exorbitantly expensive. Think about better buying power early and get intelligence about the trade space from the Services to better inform the AoA's. Consider affordability gaps at each of the relevant levels and determine the hard trades.

Mr. Miller began his comments by considering the definition and use of "near term affordability," which he described as perhaps having different metrics and perhaps even a different definition than long term affordability. As an example he related that recently the Federal Government defined the "top line" for all of government. It is flat for the future and except for the year of execution the plans to meet the respective top lines are not "tight" and the numbers are soft. Bottom line, whatever you are buying must fit within your prescribed resource envelope.

Brig Gen Stapp stated that we tend to set requirement at a level much higher than is actually needed to meet immediate operational needs. We need to look at affordability in the Department the same way we look at our household budget. If 90% of programs are over budget, then we don't have the opportunity to reallocate resources across the services or portfolios – and hence, even when reallocation with the remaining 10%, it punishes programs who are executing to the plan – in other words the system as is incentivizes unaffordable behaviors. In the majority of the programs these types of behavior drives an affordability bow wave. Best advice goes back to using the consumer approach to Defense affordability. The bottom line, whatever you are buying must fit within your prescribed resource envelope. He also made this distinction to highlight that cost estimates start with a fairly broad range of variance, (especially O&S) and as the program progresses becomes more accurate.

Dr. Diaz said that, though the Air Force (AF) has not formally defined affordability, they have discussed it at the highest levels. As a result of the fall 2012 CORONA Conference (the semiannual meeting of AF four star Generals), leaders across the AF requirements and acquisition communities met to discuss and develop initiatives to address affordability. Four of these initiatives will:

- Force affordability discussions at each of the requirements and acquisition forums through Milestone C (ICD, MDD, AoA...)
- Improve the AoA process through creating and forcing AoA criteria
- Mandate Cost vs Capability Trades/Curves throughout the lifecycle starting with the AoA
- Enhance Requirements Correlation Tables (RCTs) and the process used to create, vet, and assess them. RCTs are purely an AF AoA product that identifies the draft KPPs and KSAs and links them to the AoA analyses. The RCT forms the AF foundation to the Capability Development Document (CDD).

In closing, he challenged the workshop to (1) Develop a common lexicon so we're not talking past each other (e.g. Warfighter requirement for Indications & Warning versus the acquisition requirement of 75 nautical mile range for a radar), (2) Identify good approaches and methods (first principles), (3) Characterize how affordability changes during the life cycle from requirements through acquisition, and finally (4) Don't be seduced by the quick or easy fix.

Mr. Serna immediately posed an approach to thinking and designing for affordability. The System Engineering (SE) community should treat affordability as any other system level Key Performance



Parameter (KPP) or Key System Attribute (KSA). An attempt to apply this principle has exposed gaps in the Systems Engineering state of practice in the form of:

- Requirement prioritization tools.
- Basic tools of tradeoff analysis – that include quantitative cost variables.
- Forecasting tools – much like weather forecasting need to be updated to include:
  - Operate, Sustain, Maintain, Dispose affordability
  - Not a static but a living forecast, dynamic assessment
  - A process to look at Affordability Analysis as an evolving stochastic process.

Once these analyses are accomplished, decision authority should not permit systems with sub-optimal affordability go forward, as this impacts down-stream aspects of the capability portfolio. In summary, it comes back to responsibility, accountability, and authority to achieve affordability in the larger sense.

Mr. Bobinis offered many possible ways to improve affordability, and reflected these ideas from 6 ongoing working papers that will make up an INCOSE Affordability Working Guide for Systems Engineers in 2013. Briefly he discussed approaches for:

- Fixed price contracts/Outcome based contracts.
- Systems engineering method changes.
- The use of Value Engineering in bridging Affordability analysis across the acquisition hierarchy and System Life Cycle.
- New Operational and Support Concepts.
- Concurrent CONOPS and Requirements development and improved sharing of these findings and determination between Government and Industry.
- Definition of the Affordability effects we are trying to achieve through Analysis.
- The ability to assess cost vs. capability and ultimately evaluate relevance of capabilities against a portfolio of capabilities.
- The ability to quantify and conduct capability trade-offs, Network Centric Solutions
- How does the System of interest behave in relation to other systems, and does it increase the Value of the system?

In August 2012, the International Symposium on Military Operational Research (ISMOR) was held in the United Kingdom. One of the themes was affordability from the international perspective. After lunch, Gene Visco, FS and MORS Liaison to ISMOR, presented an overview of the discussions.

### **Working Groups Overview (Day 1 PM, Day 2 All Day, Day 3 All Day) –**

The plenary session was followed by a two and one-half day workshop. The participants met in a synthesis group and five working groups: (1) *People, Authorities, Organizations, Methods and Tools*; (2) *Development Planning and the Early Life Cycle*; (3) *Post-Milestone A and the Remaining Life Cycle*; (4) *Affordability and Logistics / Sustainment Considerations*; (5) *Expanding the Affordability Definition and Trade Space: Providing a More Holistic Life Cycle Cost and Operational Outcomes View*. The Working Group and Synthesis Group leadership is provided in Table 2. In addition to a government and industry co-chair, each of the working groups had 3-5 assistant chairs from across government, industry and academia. For a complete listing, please see Appendix C.

### **Synthesis and Integration –**

As in most MORS Special Meetings, a Synthesis Group was used to identify common themes and issues across the working groups. It is the opinion that a good synthesis effort is neither necessary





nor sufficient for a good workshop. It can make a good workshop better, but it cannot make a bad workshop good. As a result, the workshop leadership included other areas for workshop integration. Three leadership cross-talks for the working group (WG) chairs and synthesis group members were conducted after the Tuesday afternoon, Wednesday morning, and Wednesday afternoon sessions. During these sessions, each WG Chair discussed the specifics of their WG, what they found, the direction they were going, and how they addressed the workshop objectives. The goal was for each WG chair to understand what all the other WG's were doing and how they were evolving on their subject area. In addition, while the WG Leadership was finalizing their WG Outbriefs on Thursday morning, the WG Members had a cross-talk with the Synthesis Group Members about the synthesis findings.

GROUP	CO-CHAIR	NAME	ORGANIZATION
Overall Workshop	Industry	Kirk Michealson	Lockheed Martin
	Academia	Jack Keane, FS	JHU/APL
	Government	LTC John (Scott) Billie	Army Logistics University
Synthesis Group	Industry	Greg Keethler	Consultant
	Government	Dr. Jerry Diaz	USAF
WG 1 People, Tools	Industry	Bob Koury	Price Systems
	Government	Ed Blankenship	HQMC P&R PA&E
WG 2 DP	Industry	Rick Null	Lockheed Martin
	Government	Col Steve Stoddard, PhD	Center for Army Analyses
WG 3 Post MS A	Industry	Dan Klingberg	Raytheon
	Government	David Panhorst	Army ARDEC
WG 4 Sustainment	Industry	Bill Kroshl	JHU/APL
	Government	Dr. Dan Nussbaum	NPS
WG 5 Trade Space	Industry	Phil Fahringer	Lockheed Martin
	Government	Mike Knollmann	ASD(A) JOS

**Table 2 - MORS Affordability Analysis Workshop, Synthesis & Working Group Chairs**

**MORS WEB-SITE ([www.mors.org](http://www.mors.org) or [www.mors.org/events/2012aa.aspx](http://www.mors.org/events/2012aa.aspx)) –**

The workshop Terms of Reference (TOR), working group TORs, read ahead materials, and the briefs that were approved for public release are posted on the MORS web-site. The approved briefs were from the workshop kick-off, the plenary session, the working group presentations, and the working group outbriefs.

## GOALS AND OBJECTIVES

Every DoD organization is involved in affordability – either directly supporting the analysis or indirectly providing data to support the analysis. The analytic community needs to support the national security environment with analytical rigor as a key component of affordability activities. The community should play a leadership role in creating and refining these needed metrics, processes, methodologies, models and simulations. The community should share efforts, successes and failures in the key capabilities.



The overall objectives of this special meeting on *Affordability Analysis: How Do We Do It?* were to provide an assessment and a roadmap to revitalize the state of analytical rigor being applied to the practice and to recommend priorities for any initiatives identified. There were several overarching questions each working group considered, including:

- Determining the difference between cost analysis and affordability analysis
- Describing the state of practice for affordability analysis (i.e., best practices, knowledge level, cultural issues, future challenges, etc.)
- Identifying examples of how operations analysis analytical rigor has been applied to support affordability analyses
- Recommending the operations analysis needs to conduct affordability analyses (i.e., skills, tools, techniques, measures, relationships, etc.)
- Examining various considerations for affordability analyses across the life cycle (e.g., mission-based / portfolio-based / capability-based analyses; simplification techniques; trade space; mission / technology changes; and risk / uncertainty)
- Discuss the affordability of a force structure in a mission context. Can we afford the capability?

In addition to the overarching objectives and the analyst community challenges, each working group had some specific, unique objectives. These included:

- **WG 1: People, Authorities, Organizations, Methods, and Tools.** The purpose was to propose a set of standards and descriptions for the organizations, processes, and tools required to implement affordability analytics. Their goals were: (1) identify organizations that are performing affordability analysis; (2) examine skill set needed to conduct affordability analysis; (3) how do organizations, skills, and output change over the life-cycle; (4) identify tools and techniques required to do affordability analysis; (5) identify the affordability processes and their associated steps; (6) map tools and techniques to processes and steps; and (7) who are the affordability authorities.
- **WG 2: Development Planning and the Early Life Cycle.** The Development Planning (DP) and Early Life Cycle Working Group purpose was to explore methods to infuse affordability thinking and analysis into the Development Planning process. Their goals were: (1) identify current analytic affordability practices in the DP phase; (2) examine current DP analytic affordability practices and identify problems and shortcomings by looking at the requirements and gaps; (3) recommend approaches to improve current DP analytic affordability practices; and (4) identify new approaches to DP affordability analysis.
- **WG 3: Post-Milestone A and the Remaining Life Cycle.** WG 3's purpose was to identify the state of the practice, state of the art, and future trends in affordability analysis after Milestone A. Their goals were: (1) determining the difference between cost analysis and affordability analysis; (2) describing the state of practice for affordability analysis; (3) recommending operations analysis and system engineering needs to conduct affordability analyses; (4) examining various considerations for affordability analyses across the life cycle; and (5) discussing the affordability of a force structure in a mission context. Can we afford the capability?
- **WG 4: Affordability and Logistics / Sustainment Considerations.** WG 4's purpose was to determine ways to increase the visibility and role that supportability plays in the acquisition cycle. Their expectations were: (1) provide a forum for discussing Defense Department and Allied approaches to affordability analyses throughout the life cycle; (2) provide an



opportunity for operators, engineers, decision makers, academicians, and military and civilian operations research analysts; and (3) to examine tools, models, methodologies, analyses, and innovations in affordability analysis pertinent to all aspects of sustainment.

- **WG 5: Expanding the Affordability Definition and Trade Space.** Working Group 5's purpose was to discuss the affordability trade space. They developed responses to the following questions: (1) What are the best approaches to examine the trade space associated with affordability with respect to readiness, capability and risk? (2) How can we best represent risk in terms of the uncertainty associated with meeting the desired outcomes? (3) How do we balance the affordability of a system within a portfolio of capabilities all aligned to a similar mission? (4) What other affordability contexts (e.g. mission-based assessment) might provide a more meaningful perspective for analysis?

## **WORKSHOP DISCUSSIONS AND FINDINGS**

### **AFFORDABILITY**

The consensus of the working groups coming into the workshop was that clarity of definition, sufficiency criteria, and regulatory policy are consistently absent from affordability analysis. Affordability is not a number, but a decision and may vary depending on the stakeholder or the decision maker (i.e. affordability is in the eye of the beholder). For example, for the

- Size Dimension: DoD, Service, Mission Area or System
- Measurement Dimension: Dollars, Lives or Time
- Phase Dimension: Requirement, Acquisition or Operation (e.g., the Chemical Demilitarization debacle (decades consumed and \$B spent) suggests that End of Life Retirement and Disposal are REAL life cycle costs that need to be considered. Any affordability analyses needs to think about environment and health effects of any nuclear, heavy metal, or the like in the future.)

When one conducts cost or cost-benefit analysis, the process is straightforward; analysts follow established guidelines and principles. However, when conducting affordability analysis, responses vary dramatically. Guidance, processes, and institutional acceptance are needed though tools and methodologies were not considered the binding constraints at this time.

Unlike cost, affordability is not an inherent attribute of a program or requirement, although it is often treated as such. Affordability does derive from inherent attributes of a program or requirement (such as cost), but is an informed judgment—a “relative” comparison of something compared to something else. Affordability is commonly thought of as a relationship between capability and cost, but there has been no metric or singular set of metrics defined for either.

Initially, there were two interpretations of affordability in use.

- Affordability in the “small” means being frugal—being cost efficient in executing a program, from beginning to end and not being extravagant in choosing capabilities and solutions to challenges; getting the most bang for the buck (“little a”).
- Affordability in the “large” means, assessing whether this capability – considering what it is going to cost (or is costing us) – provides sufficient value in the context of all of the other things we need (“Big A”)

Contractors, program managers and others tend to operate in the “little a” realm (i.e., doing things right), while DoD, Congress and Service leadership usually mean “Big A” (i.e., doing the right things).



Affordability in the large is a judgment call. That judgment can change over the life of a program for many reasons, some of which may have absolutely nothing to do with the “little a” of a program. The nature of analysis to support the “A’s” differs somewhat due to the nature of the associated questions.

## **AFFORDABILITY ANALYSIS AND COST ANALYSIS**

During the workshop, the working groups were asked to discuss the difference between affordability analysis and cost analysis. A consistent theme was that cost analysis is a dollar breakdown of the implementation effort, tactical in nature, and tool oriented. In contrast, affordability analysis is strategic in nature; it looks at trade demands, dollars per capability, return on investment; and requires a behavioral change in culture. Affordability analysis is

- The analysis of a portfolio to identify best mix of capabilities to achieve the mission at least cost
- The analysis of a system to minimize the cost of achieving the desired capability over the full life cycle

Cost Analysis primarily considers the monetary and financial aspects of an acquisition. Individual cost elements of a system or platform are investigated, estimated and accumulated to arrive at an overall cost. Cost Benefit Analysis compares cost of numerous alternatives to the benefits they provide to inform the course of action selection. Capabilities Based Assessment is a Joint Capabilities Integration Development System (JCIDS) activity designed to identify and prioritize capability gaps and risks. Once a framework is developed, affordability analysis will be a broad examination of all costs (development, acquisition, operations and sustainment, retirement and disposal) of an acquisition program along with how well the program fills needs within an overarching force structure or capability portfolio.

From working group discussions, the participants determined cost analysis, cost benefit analysis and capabilities based assessment each contribute to affordability analyses. Cost analysis provides the basis for costs used in an affordability analysis. Cost benefit analysis additionally provides solution advantages, quantifiable and non-quantifiable, which affordability analyses incorporate as value or military worth of the acquisition program. Capability gaps, priorities and risk output from capabilities based assessments serve as foundational elements in an affordability analysis. These gaps, priorities and risks form the basis for evaluating acquisition program costs and benefits against fulfillment of stated capability and reveal how well the acquisition program does or does not satisfy DoD objectives within affordability targets.

## **STATE OF THE PRACTICE**

What is the state of practice for affordability? The consensus across the working groups was that it was weak, although there are pockets of successful affordability efforts; however, analytic rigor in affordability analysis has not been institutionalized: there is no agreement for

- The standards for the tools needed,
- The framework necessary, and
- The consistent methods.



A rhetorical question was asked: “Is the focus by leadership on rigor and quality or getting to and through the Milestones?”

Looking across the three classic areas of Process, People and Tools, a stoplight chart was created by one working group. The Processes would be RED (broken or nonexistent and not formalized), People as YELLOW (some shrinkage of the analytic base occurring and the need for the combination of analytic capability and acquisition knowledge and experience), and Tools as GREEN (sufficient tools available).

Process was discussed in the “Major Recommendations: Affordability Processes” section. Regarding people, the major problems are the institutionalization of who sets the affordability targets and who is responsible to see that they are met, the need for people with both analytic and acquisition experience and knowledge, and the general decline in the number of uniformed analysts (at least in the Army). The aging work force increases the risk of a “brain drain” if efforts are not begun immediately to hire, train and mentor replacements.

Tools are in pretty good shape. The consensus was that the operations analysts know how to do the things needed to be done. The real problem is that the decision criteria for affordability are neither well defined nor socialized. Parametric and analogous cost modeling capability exists, but is not well integrated. There is increased activity in multi-dimensional visualization and model based development, but the capabilities are not mature. As stated previously, the problem is essentially a Capital budgeting problem, the tools for which go back to Dantzig.

With that said, there were a few examples of analytical rigor that provide potential insight to development of guidelines for other activities to improve affordability analyses.

- 1) OSD(CAPE) develops the Defense Planning Projection (DPP). The DPP is a portfolio-by-portfolio of systems which shows funding, ages, and inventories over a 25-year time period. [NOTE: Since these portfolios are not well known outside OSD(CAPE), as affordability analysis portfolios are defined, the OSD(CAPE) portfolios will need to be reviewed just like the Capabilities Based Planning portfolios and the Joint Capability Areas.] It is developed with service inputs and FYDP values, and uses best available knowledge about what might happen in the post-FYDP years. It is valuable for affordability analysis for two primary reasons:
  - a) Because the time horizon is beyond the FYDP, it shows where there are potential bow waves that allude to affordability challenges. In these cases, decisions in the early lifecycle might be able to improve affordability.
  - b) The DPP groups all systems into portfolios. Definition of portfolios is always a challenge, but the DPP has a consistent, year-to-year approach that serves as a start point for trades among like systems.

The challenge with the DPP is that it is not tied to any specific aspect of a decision making process. It could be used as a start-point for services’ affordability analyses, and perhaps in conjunction with AoAs.

- 2) The Joint Light Tactical Vehicle Program (JLTV) provides an example where affordability analysis drove real trades to make a system viable. The affordability analysis portion of the AoA showed that JLTV would be a significant challenge for the Army and Marine Corps to fund. The AoA was completed well before the milestone decision point. Specifically, the services decided to remove the requirement for sling-load transportability in favor of a more affordable vehicle that still offered good personnel protection. Further, the cost of meeting



the KPPs was so high that it became clear that the program would be cancelled altogether without substantive changes. So trades were made and the program advanced through the milestone. The key point here is that the analysis was complete in time for those trades to be made before the milestone decision point, which makes the tradeoffs much less costly than if they were done downstream.

- 3) The Three-Dimensional Expeditionary Long-Range Radar Program (3DELRR) provided an example of rigor in that it enabled good collaboration between the service and industry. The Air Force issued an RFP that provided operational context but was less prescriptive than usual in assigning performance and cost targets. This allowed industry to offer alternatives that included trades between performance and cost, which in turn gave the Air Force viable alternatives from which to choose. The Air Force gained more benefit from industry's technological development and innovation, and industry was able to make better-informed investment decisions. From the perspective of the industry members, this was a positive change in behavior by the Government.
- 4) The JSF cost forecasting methodology used by Canada to determine National Procurement (sustainment) estimates for new systems based on existing systems is a peer reviewed process using existing data to assist in forecasting the sustainment costs. It is useful if analog systems and usage patterns exist and it facilitates sensitivity analysis under various scenarios of use. It provoked much discussion on the proper way to estimate sustainment costs for a system that is still under development with some analytic rigor and a basis of more than folklore and rules of thumb. There was discussion as to how this methodology could be adapted to other types of systems such as ground vehicles, and the kinds of data requirements that such an analysis might require.
- 5) Although most of the participants were familiar with fully burdened costs (FBC), they are not often used in CBAs. The focus of the Army's Fully Burdened Cost of Fuel methodology discussion in the working group related to the impact of the use of FBC on sustainment decisions, and how they more accurately reflect trade-offs that are often done early in the development cycle such as buying less expensive (and less energy efficient) engines or insulation on equipment. There was also discussion engendered on how some other sustainment issues might be affected by fully burdened costs (batteries, consumables, etc.) and the difficulty of really estimating fully burdened costs and how the very expensive situations (such a bringing fuel to an isolated forward area) might be better served by looking at increased warfighting capability vice increased sustainment costs. While a commander (or decision maker) might not care that a certain engine saves "x" dollars per day in fuel cost while in combat, they may very much care that it allows them, with organic logistic support to operate for "y+3" days rather than "y" days in the field – rephrasing the problem so the warfighters could understand.

## MAJOR RECOMMENDATIONS

The MORS Affordability Analysis Workshop was timely, providing needed discussions from key leadership, organizations, and individuals. However, the matter should not end here. A small core group, perhaps the core of a new MORS Affordability Analysis Community of Practice, could be established to continue working with the government on the above workshop recommendations.

These are the major recommendations from the workshop. More amplifying information on these will be discussed later in the final report.

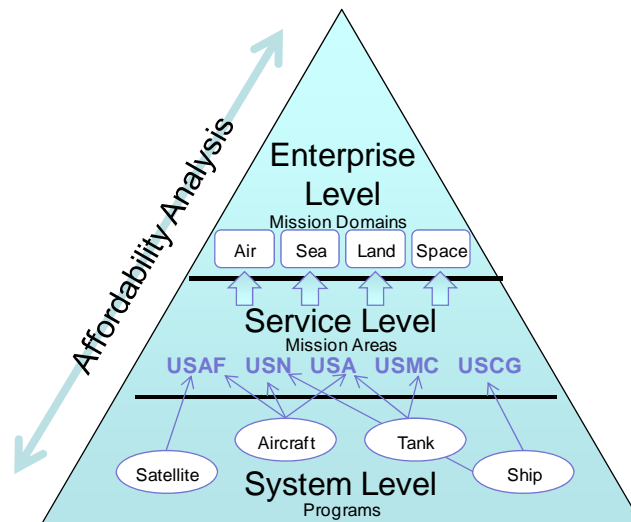


- Define affordability analysis concepts, including portfolios
- Develop an affordability analysis “how to manual”
  - People, authorities, skills, processes, methods, data and standards
  - Drivers, strategies, information needs, metrics and analyses across the life cycle
  - Relationship between resources and readiness
  - Best practices from other organizations (i.e., FEDEX, UPS, Amazon, etc.)
- Identify organizational accountability across the full life cycle
- Develop a trace-back capability for key decisions

## AFFORDABILITY PORTFOLIOS

Affordability is inseparable from prioritization. Because affordability is more of a concept than a fixed number such as cost, “things” may become affordable if they are higher priority than other investments or alternatives. Affordability analysis illuminates what is achievable within a portfolio. The portfolio, however it is defined, is relevant and must be thoroughly examined to ensure that decisions are made with respect to the appropriate offsets. Affordability analysis considers what DoD can afford to forego (i.e., assessment of risk): it is a matter of comparison. Decision-makers’ acceptance that something is affordable implies that they have agreed that something else is unaffordable.

Affordability analysis occurs at many levels. Each level provides a specific context and set of assumptions, constraints and procedures. As an example, Figure 2 shows three levels of affordability analysis: (1) Enterprise / DoD Level for Mission Domains, (2) Service Level for Mission Areas, and (3) System Level for Programs.



**Figure 2 – Affordability Analysis at Different Levels**

It is important that the analysts adopt a holistic, portfolio view regardless of the level of the analysis. The level determines the scope of the analysis, as well as the actors and decision makers involved. There are numerous aspects associated with the concept of affordability analysis and more specifically with the concept of the associated trade space. These need to be distinctly clarified any time affordability analysis is being conducted.



As an example of the “little a” and “Big A” concept and portfolios, there are at least two distinct but related primary perspectives and contexts. These are the system level and the portfolio level.

- **SYSTEM LEVEL:** The distinction is that at the system level the affordability analysis and associated trade space is concerned with requirements, capabilities, costs and risks of various options for elements of a system. For instance – analysis of what type of radar system to include on an aircraft would be conducted from the aircraft system level perspective and the context would be the cost and capabilities of the various radar options, and how well they met the requirements of the aircraft and the associated risk of not meeting the requirements of the aircraft.
- **PORTFOLIO LEVEL:** This is contrasted with the portfolio level perspective for affordability analysis and the associated trade space. The portfolio level has a different context for requirements, capabilities, costs and associated risks. At the portfolio level different sets of systems are evaluated against the requirements to perform a mission, and the capability is defined as the combined capability that the portfolio of systems brings to bear against the mission requirements. Further, the primary measure of risk is the risk associated with the shortfall of the portfolio capability against the mission requirements, both in likelihoods and magnitudes. For instance, depending on the specific mission requirements, a portfolio may be found to have sufficient capability to meet the requirements 80% of the time, and therefore the risk is 20% that requirements will not be met. Perhaps of that 20% of the time that requirements aren’t met, we find that 70% of the time 90% of the requirements are met, but that there is a 10% chance that less than 50% of the requirements will be met. This provides leadership and decision makers a more complete perspective of risk as compared to color codes and will enable a much more robust discussion regarding the trade space of which portfolios of systems are most affordable in terms of achieving mission level outcomes at acceptable levels of risk of not achieving mission outcomes.
- Ultimately, the portfolio perspective enables not only trades among systems as various systems are incorporated or removed from a portfolio, but it also enables trades among different sets of systems and their overall capability contribution towards achieving mission outcomes. This, of course, means that there are multiple portfolio perspectives.

Analysts possess skills and tools to enable optimization of portfolios, but there is insufficient definition of what portfolios exist, what is trade-able across them, how costs are allocated, and a common measure of capability to do so (e.g., the Return on Investment or ROI). Essentially, portfolio analysis is a Capital Budgeting problem, with roots going back to George Dantzig and the origins of Linear Programming. These capital budgeting problems are elegant and appealing concepts in the abstract, but they require extensive definition to actually execute, and very few organizations are specifically tasked to do this beyond the Future Years Defense Plan (FYDP), nor when to do so across the life cycle. To trade capabilities across programs as well as within and across portfolios, it is necessary to very specifically define the portfolios, the measure of capability, the cost allocation schema, and the necessary constraints. The analytical tools and skills exist to do these analyses and the analytic community is eager to help set the stage and execute for success, but the foundation for analysis does not exist yet.



A consistent view of portfolios should be developed that:

- Should be consistently decomposable across the Services Total Obligation Authority (TOA)
- Are mission focused with defined mission requirements (not system requirements) and include collaborative interaction with industry.

For defining these affordability analyses portfolios, the workshop attendees recommended starting by reviewing three different activities:

- 1) The portfolio analyses that were a key part of DoD's shift to Capabilities Based Planning (CBP) a few years ago,
- 2) The current Joint Capability Areas (JCAs).
- 3) The portfolios that are part of the current Defense Planning Projections (DPP)

Perhaps there is a strong relationship between the portfolio analyses needed for affordability analysis and the JCAs and CBP / DPP portfolio analyses. In any case, once the mission portfolios are determined, then the associated measures, cost allocation, and constraints can be defined and the analysis can proceed.

As the affordability levels and portfolios are consistently defined, a context with a lexicon should also be considered. Some information to be included in this lexicon could be like the affordability "little a" and "Big A," but called "little c" or "Big C" for capability. Capability requirements, according to JCIDS manual, are not supposed to prejudice capability solutions. This is in effect a "Big C" capability. The Big C capability is at the mission level and can be satisfied by either a materiel or non-materiel solution or some combination of both. Immediately there is a distinction between the capability need and the solution that satisfies the need. It is at this level that affordability potentially has the biggest impact. There is also a "little c" capability at a program / system level as it is sent to the contractor in the form of a system specification. Thus, there needs to be a distinction in the different "capabilities" based on the context in which it is used.

## **AFFORDABILITY PROCESSES**

The process, methods, and, most importantly, the data needed to conduct effective affordability analysis are not available. The current model of the system life cycle which is taught at the Defense Acquisition University (DAU) – that all acquisition professionals are familiar with – does not adequately address affordability. Requirements are treated as something that is done mostly pre-Milestone A and then static, i.e., never changing nor affected by budget considerations. This is simply not reality. As a result, (1) Bow waves are created that present challenges to affordability, and (2) Beyond the FYDP no one seems to be held accountable for these bow waves.

Our process for budgeting and procurement focuses on the FYDP and procurement costs, not on the life cycle. In the Development Planning phases, decision makers can be blind to affordability issues that are beyond the FYDP. The most significant costs and affordability challenge in the early lifecycle lie beyond the FYDP. Affordability analysis must be conducted using the full range of costs. Because data are frequently lacking, some affordability analyses exclude O&S costs. But O&S costs can represent a majority of the total costs of some systems – particularly those that need fuel, manpower, or spare parts. As such, analysts should employ ranges of costs to offer comparison. Some alternatives (e.g., the systems currently in inventory) will have fairly well-developed cost estimates, and comparisons of these estimates to ranges for new systems will help support decision makers.



While affordability analysis is mandated at various points in the development process and lifecycle, there is no clear statement of who sets the affordability targets or what methodology should be used to set those targets. Program managers have no control over sustainment budgets and, more importantly, no incentive to reduce the costs of sustainment. In effect, better decisions that might reduce sustainment costs (which the program manager has no incentive to reduce) are often traded for lower procurement costs (which the program manager has every incentive to reduce). Lower sustainment costs, in most cases, result in lower lifecycle costs. Our process forces us into a position where we are sub-optimizing procurement.

Recent changes in the acquisition process codified in DoDI 5000.2 direct that affordability and affordability targets be treated as KPPs, but these are in the early stages of implementation and do not affect the vast majority of systems already fielded. While these are good steps, a process for current systems need to be developed and implemented. A consistent framework for the conduct of affordability analysis is needed. A comprehensive context for analysis, such as a 30-year look, needs to be developed that includes all systems – existing, proposed and imagined – and should be evaluated within the affordability analysis context against the consistent portfolio view. This will establish a baseline, from which we can measure change and understand the penalty for change (costs, risks, impact on outcomes).

Basically, a "how to do it" manual with the framework needs to be created describing the tenets of affordability analysis, some examples, tools, and process suggestions. There is already a guide for Cost Benefit Analyses that could be used as a guide to get started. Additionally, in the Defense Acquisition University Defense Acquisition Guidebook, Section 3.2 is "Affordability". This section provides guidance with examples on how to conduct affordability assessments. At 10 pages, it may not cover everything recommended from the workshop, but it could be used as a foundation for a new guide. In any case, as this process / how to guide is being developed, two very important questions need to be answered:

- (1) What are the questions any affordability analyses should answer? and
- (2) What are the criteria of a successful affordability analysis?

Some elements to incorporate in the framework include:

- Context to conduct analysis (Problem Statement)
- Items that need included in completed analysis for different phases of affordability analysis (data/assumptions)
- Definition of consistent portfolio sets and when to use each comparative set
- Definition of analytic elements to include in each phase of affordability analysis
- Analysis that includes ability to adjust parameters to evaluate against a range of input parameters and global scenarios
- A requirement for concise communication of entire trade space, rather than a single recommendation
- When this detailed level of analysis needs to occur (and when it is less expensive just to press forward)

Part of this affordability process and infrastructure is the program authority, responsibility, and accountability. These are currently fragmented across the life cycle of a system (concept exploration to disposal), spread across different phases of the life cycle, and spread across various organizations and people. The results are that decisions are made without full accounting of true and complete costs because full O&S costs are typically not accounted for in the development or requirements



phases. This creates that unseen technical debt bow wave described previously by deferring technical needs from one phase of the life cycle to another. It postures subsequent phases for failure, since problem resolution is more expensive the later it occurs. It results in apparent affordability in FYDP, i.e., may be able to buy, but don't have funds to maintain or drive.

Additionally, interaction and dialog with industry is essential. New ideas, new technologies and concepts are fostered within industry and play an important role in understanding potential ways and means to meet emerging capability requirements. However, legal implications often stifle dialog, information exchange, and participation with industry. The Office of Management and Budget (OMB) has issued guidance in the form of "Myth Busters" regarding common misconceptions of government and contractor interactions and information sharing (OMB Memorandum For Chief Acquisition Officers, Senior Procurement Executives, Chief Information Officers, "Myth-Busting 2: Addressing Misconceptions and Further Improving Communication During the Acquisition Process" dtd 7 July 2012). Early sharing of capability gaps and needs with industry allows better alignment of research and development funds and focused technology development enhancing affordability in the long term.

### **AFFORDABILITY LINKAGES**

A related issue is the lack of linkage of key data and information needed across the life-cycle. A mechanism to keep data, assumptions, decision criteria/rationale, tools, and other key elements of information (e.g., system model, system analytic framework) across the life-cycle is lacking. This is exacerbated by the time lapse between initial concept development and system maturity and results in redundant or conflicting decisions which add significant costs, and no ability to trace back. An example is where the Operational Test & Evaluation (OT&E) objectives and approaches should link directly back to the Analysis of Alternatives (AoA), but the detail needed is usually long gone. A mechanism needs to be established at the inception of the requirements process and to update and maintain it through each phase of the life cycle and formally pass on to the next phase.

There is the need to develop a means to track changes in assumptions, KPP's, threats and other bases for requirements throughout the program. The thought about tracking decisions across the life-cycle is there, but it needs to be expanded to include these other elements. The point is that these things get incrementally changed as the program moves along and there is no record, nor traceability of it.

### **THE AFFORDABILITY ANALYST**

Another point the working groups discussed was what was needed from the operations analyst to conduct affordability analysis. The attendees agreed that analysts need a good understanding of what affordability analysis really is and the associated deliverables – i.e., clear guidance on affordability analysis to include delivery of products that include a portfolio view, the total ownership costs over the long-term (post-FYDP years), and trade space between cost, quantity, performance, schedule, and risk. Perhaps this guidance could be part of the AoA Guidance and specify that analysis include a portfolio view, the out years beyond the FYDP, and trades between cost, quantities, performance, schedule, and risk.

Affordability analyses must be conducted prior to Milestone A, despite challenges in cost analysis. Because cost analyses in the development planning phase are conducted without the benefit of firm data, such analyses must include the full range of costs. Cost analysts can be assigned to contribute



to the task of analyzing affordability for the operations analyst. When this happens, they must be paired with people that have a greater understanding of the performance, comparable systems, the operating environment, and the great portfolio. The recommended knowledge needed for affordability analysis is a basic Operations Research / System Analyst (ORSA) skill-set plus understanding of the acquisition process and decision analysis skills in order to analyze comparative choices.

## **ADDITIONAL SUGGESTIONS**

First, life cycle considerations have already been previously stated, but these points are key: no one is responsible for setting the affordability targets, there are no standard methodologies for determining those targets (which should take the entire DoD enterprise into account), and lifecycle costs are needed to affect procurement decisions. Affordability targets should be a range of values, not point values. They will evolve over time. How are sustainment affordability targets determined? There is much uncertainty in setting sustainment cost targets, but the following questions should be answered:

- Who is or should be responsible for establishing sustainment cost targets?
- How should affordability targets for sustainment be established? (Look at current programs?)
- Should we have a cost baseline for lifecycle cost?
- How are new systems assessed?

Then, it will need to be determined if the target changes over the life cycle. Different methods for estimating the sustainment cost at different points in the life cycle may be employed, but the overall target should remain the same – unless the operating concept or concept of operations changes, or the program is re-baselined. Workshop participants recommended to develop risk-adjusted O&S cost estimates. Then as the program matures, the analyst can try to narrow down the confidence intervals.

Next, can a quantitative relationship between capability and cost be defined in order to help achieve affordability? Investment cost and resulting capability are key elements of an affordability analysis, as well as reliably relating and quantifying cost and capability. A simple cost and capability quantitative relationship may be expressed as “bang for the buck.” That is how much is spent to yield a certain level of capability. This is the basis for Cost as an Independent Variable (CAIV) approach. For numerous investment levels (cost), the amount of capability delivered is measured. This collection of data is then sorted by least cost for most effect to develop the CAIV curve. A CAIV curve identifies diminishing returns, the point at which more investment results in small increases in capability. The amount of capability achieved for the cost invested may be a qualitative estimate by subject matter experience or may be derived from detailed modeling, simulation and analysis.

At a more detailed level, a framework may be developed to measure capabilities and optimize solutions based on investment cost and budget available within constrained performance parameters. Similarly, an affordability function may be expressed which includes cost, value (capability achieved) and technology. Using these relationships, an affordability “ceiling” (affordability target) may be imposed. The volume below the ceiling becomes the feasible, affordable solution trade space.

Finally, there should be an iterative process between the mission area proponents as the capability need enters the JCIDs process and migrates to become a major acquisition program.

Recommendations include:





- Allow programs and contractors to explore relaxed requirement constraints in search of affordability-rich ranges of performance
- Establish streamlined processes to approve these relaxed requirements when such high potential affordability regions are found

For performance requirements, threshold values are set for KPP's without full knowledge of how they will drive cost for the system. For example, if a KPP has threshold performance value of 500 miles, then the acquisition process holds 498 miles to be a failure – even if it halves the cost or development time. The point is that if fixed point standards are relaxed to a performance range (where even the endpoints of the range are re-visitible), then the range may provide the opportunity to significantly reduce the development and procurements costs of a given system – while still meeting the fundamental mission needs. The same may also apply to cost ceilings or targets, which can lead to penny-wise but pound-foolish decisions. History is rife with examples of Service proponents holding to rigid performance standards with no consideration of either the engineering feasibility or financial impact. This needs to be changed in the name of pursuing affordability.

### **SPECIAL PRODUCTS**

During the workshop, a couple of working groups started some products that are related to our major recommendations. Here are brief descriptions of three of these products, all relating to the affordability processes and linkages.

### **GENERIC AFFORDABILITY PROCESS**

Figure 3 is a suggested view of a generic affordability process which illustrates many of the ideas, concepts, and issues that are articulated in the output of Working Group 1. First and foremost one should recognize that singular tools, or methods are not considered affordability tools or methods as such. They are typical or familiar methods and tools used by many analysts for other studies and purposes. What makes them affordability analysis tools are their contemporaneous use within a process like the one depicted in this graphic.

This figure shows key components that need to be included in an affordability process:

- Starting in the upper left hand corner the mission or purpose context of the affordability analysis must be set. For combat systems this would come from mission scenarios (data) and combat simulations (tools).
- We provide some description of the system, product, or services (Work Breakdown Schedule (WBS) or architectures)
- The various systems are then subjected to a “swirl” of analysis (see the center boxes – cost analysis, risk analysis, performance analysis and schedule analysis)
- These considerations are ultimately balanced within a decision makers value framework subject to a budget, TOA, or other affordability cost constraint
- Finally the results of the analysis must be presented in a logical and intuitive manner for decision-makers

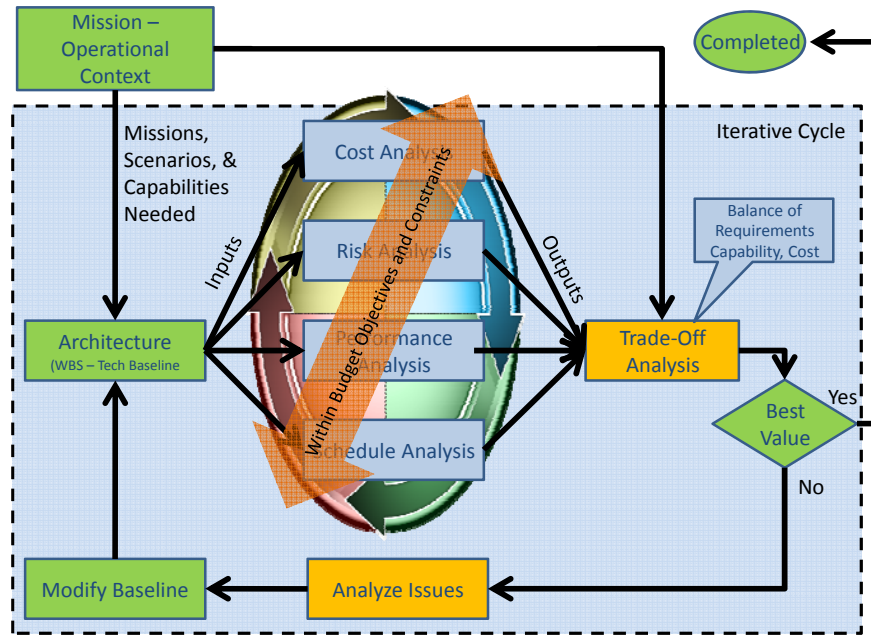


Figure 3 – Generic Affordability Process

### AFFORDABILITY ANALYSIS PEOPLE, PROCESS AND TOOLS MATRIX

Affordability requires a holistic approach spanning from the executive and legislative branch to the program-level or may be characterized as participation at the enterprise, portfolio and program levels. As a result, Working Group 1 created an Affordability Analysis Taxonomy that describes breadth of the solution space in non-hierarchical terms. Affordability analyses at these various levels will not be the same, but the results from one level should relate to those of another.

Analysis Context	Context Definition
Oversight/Audit	Strategic/Tactical (as appropriate) assessment of cost, schedule, performance and risk
Strategy	KPP's/Requirements derived from National Defense Strategy/ies and associated prioritization of mission needs. AoA used to generate a prioritized portfolio.
Prioritization/Allocation	Prioritization of KPP's/Requirements and Allocation of Capabilities to Strategy/ies (and/or associated KPP's/Requirements)
Resourcing	Allocations of resources/trades
Execution	<ul style="list-style-type: none"> <li>Government: Achieve affordable solutions</li> <li>Supply Chain: Deliver affordable solutions</li> </ul>

Table 3 – Affordability Analysis Taxonomy

Working Group 1 also created a matrix of people, authorities, skills, processes, methods, measures, data, and standards for each level of oversight for affordability analyses (see excerpt in Table 4). The matrix was created for each level of oversight: National, Enterprise, Portfolio and System. Other notes about this matrix include:



- Tools – A number of in-house tools and models (e.g., Excel, VBA, etc.) are utilized across the levels; idiosyncratic and uncoordinated approaches.
- Data – Requires collaborative solution development – an innovative partner; a long-term trust and partnership for development and sharing of data

Level	Description	Who	Authorities	Skills	Process	Methods	Tools	Measures	Data	Standards
Prioritization of Requirements / Portfolio	Prioritization of KPP's/Requirements and Allocation of Capabilities to Strategy/ies (and/or associated KPP's/Requirements): 1. Allocation of operational capability.	J-8	Joint Staff	Financial Managers	Requirements prioritization Analysis of Alternatives;	TRL Levels	MARCUS (Can); Time Decision Support Dashboard	Contribution to Mission Success AoA with requirement relief (trade off of mission capabilities)		
		JROC (Portfolio)	JROC	ORSA		Sensitivity Analysis Uncertainty Quantification in Risk Analysis				
		Joint Staff	Service Chiefs	Systems Engineers		Data Mining (historical data) to develop predictive models M&S	Design of Experiments (DOE)	Multi-variant trade offs (perf/cost metrics)		
		BSO DoD Component Capability Organizations (E.g., USMC, USN, USNavy, USNavy, USNavy) Resource Sponsors Portfolio/Enterprise	Components: Budget Resource Sponsors			Design of Experiments  Better Baseline Analysis	Reliability Software Data Mining Software  Data Viz Software GAMS (Optimization) Combat Value Added			

**Table 4 – Affordability Analysis People, Process & Tools Matrix**

The next steps are: (1) complete it, filling in all the cells; (2) coordinating across government and industry to ensure accuracy; and (3) inclusion in overall affordability analysis process.

## AFFORDABILITY ANALYSIS INFORMATION NEEDS MATRIX

Working Group 2 identified drivers (key decisions), strategies (key considerations), information needs, metrics and analysis needs for all phases of the life cycle: Technology Demonstrations, EMD, production and deployment post MS C, O&S, and Cross-Cutting, Cross-Phase, and Other Considerations. Figure 4 is the example from the EMD Phase. The other phases are in the back-ups to the Sponsor / Proponent Brief (Appendix G) and the Working Group 3 Outbrief (Appendix J).

### Drivers (Key Decisions)

- Considerations during EMD that can impact affordability
- Interim impacts through the development

### Strategies (Key Considerations)

- Adaptability/flexibility to enable emerging requirements/behaviors
- Modular Open Systems Architecture (MOSA) can help manage
- Common platforms that can evolve over time; evolutionary approaches
- Cost reduction opportunities
- Management of Key Critical Parameters – match mfg process capability
- Culture change focused on affordability
- Have more than one party compete during EMD phase for high risk programs

### Information Needs

- Terms needed to make affordability work
- Cost requirements
- Interfaces and interactions between the system and enabling systems
- Materials and manufacturability
- Security/Cyber-Security

### Metrics

- Sustainment maturity/effectiveness
- Manufacturing Readiness

### Analysis

- Modeling and simulation to better analyze trades
- Is the system/element suitable?
- Cost modeling disconnects
- Need to have a robust cost-modeling capability developed
- Continued use of cost modeling and analysis needed throughout the phase and life cycle
- Shared cost modeling to enable better communication, expectations and affordability decisions
- MOSA can also reduce risk
- Materials and manufacturability trades
- Operations and sustainment costs and trades
- Supply chain delivery timing
- Test coverage

**Figure 4 – Affordability Analysis Information Needs: EMD Phase**

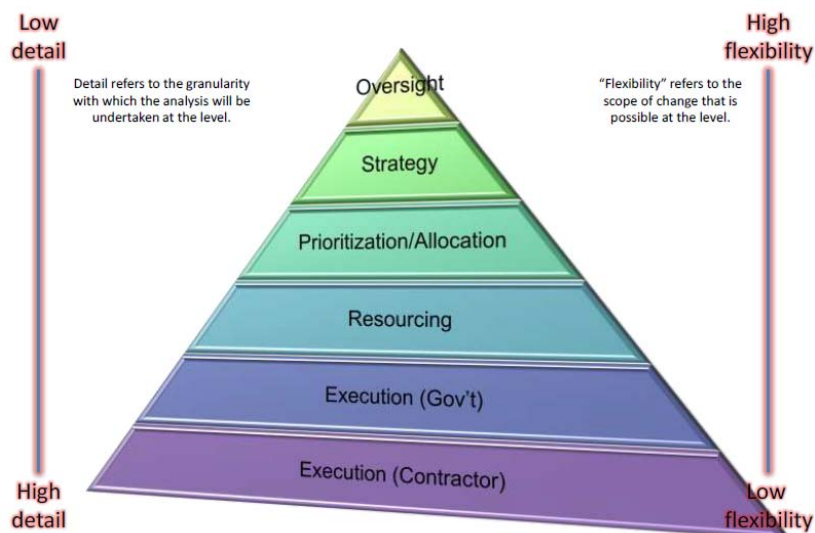
## ADDITIONAL WORKING GROUP FINDINGS

There were numerous working group specific findings. Here are some highlights.

**Working Group 1, People, Authorities, Organizations, Methods, and Tools** – Affordability requires a holistic approach spanning from the executive and legislative branch to the program-level or may be characterized as participation at the enterprise, portfolio and program levels. As a result, Working Group 1 created an Affordability Analysis Taxonomy and the descriptions of the levels are in Table 3. The Analysis Context in Table 3 describes breadth of the solution space in non-hierarchical terms. Additional Taxonomies (or, at the least – categorizations) could be: (1) Enterprise, Portfolio, Program or (2) Federal, Departmental, Contractor. Affordability analyses at these various levels will not be the same, but the results from one level should relate to those of another. The scope or budget constraint varies depending on the level of analysis. There is good visibility at the program (execution) level but not at the portfolio (capability) and enterprise (strategic) level. This necessitates a need for high degrees of transparency needed for appropriate aggregate views.

The maturity of affordability analysis varies across levels. For example, we know how to do an affordability analysis for tanks (program) but not on a direct fire capability (prioritization or resourcing). Other critical observations about the budget in affordability analyses include:

- Survivability is defined by the threat as affordability is defined by the budget.
- Thus understanding the budget constraint at each level of the analysis is paramount.
- Budget constraints at enterprise and portfolio levels need to be presented stochastically as opposed to point estimates to substantiate trusted analysis
- Affordability analysis will be enabled by transparency of the budget and other value factors from the enterprise to the programmatic level.



**Figure 5 – Affordability Analysis Taxonomy Pyramid**

Figure 5 is an illustration of the affordability analysis taxonomy of relationships. What is important about this illustration is the detail and flexibility characteristics of this framework:

- Detail is low at the oversight level and increasingly higher as we enter the execution functions



- Flexibility or degree of change that is possible is higher at the oversight level than it generally is at the execution level.

It is worth noting that a small change made at the oversight level (like a 1% budget cut) can have very wide effects at the levels below.

**Working Group 2, Development Planning and the Early Life Cycle** – Working Group 2 (WG 2) was asked to discuss other areas of affordability analysis as it relates to Development Planning. WG 2 discussed which components of life cycle costs tend to generate un-affordable solutions pre-Milestone A. Numerous factors may influence where the final cost point settles. Two of these factors noted here are mistakes and poor decisions.

Mistakes drive un-affordability when point estimates are used for a variety of pre-Milestone A costs. At this stage, predictions for development, acquisition and operating and sustainment (O&S) costs should include a range of uncertainty to inform the affordability analysis (and decision makers) of “just how bad it could get”. Better that understanding now than a Nunn-McCurdy breach later. It is also key to re-visit, keep current and update the ground rules and assumptions as the program moves forward. If changes in these are not captured, understood and documented more error is driven into acquisition estimates amplifying opportunity for un-affordability.

Developmental Planning decisions cause un-affordability when focus is concentrated on acquisition costs and FYDP concerns while minimizing or ignoring O&S cost. When near term concerns dominate, likelihood of un-affordability increases. Affordability analysis must use an “eyes wide open” approach and base decisions on the expected total life cycle program cost. Program affordability can also be enhanced by early adoption of top level logical architectures that facilitate capability trades and drive cost control. Conversely, lack of sound architecture practices limits capability trade space understanding and particularly in large, complex acquisitions, leads to un-affordability.

A distribution or range of costs should be used when estimating. Avoid single point estimates that flaws in the analysis. A simple triangular distribution for cost elements stating expected cost, minimum cost and potential maximum cost addresses and bounds uncertainty. Document the ground rules and assumptions behind the estimates and examine them for relevance and appropriateness. Develop an affordability analysis study plan with a comprehensive range of “what if” or sensitivity analysis on cost, schedule, performance and risk. Document, bring forward and report sensitivity results and how they affect affordability. Identify drivers of uncertainty and apply lessons learned and past program performance history to isolate, control and reduce uncertainty. Resist tightly constraining the trade space available; it probably will not lessen uncertainty and can stifle innovation and flexibility in solution development. Introduce analytic methods such as stochastics, Monte Carlo randomness and probability theory to address uncertainty concerns and develop a range of possible outcomes to inform decision makers. Understand key tradeoffs and how they are affected by uncertainty. Apply uncertainty principles at the portfolio level to gain insights to portfolio interactions and how cost and effectiveness respond. Identify what uncertainty is associated with acquisition and sustainment affordability targets – will they change and what ripple effect(s) can result? Address risk by analyzing severity of risks and the probability of occurrence. Focus attention and analysis on high risk factors which have high probability of occurrence. Develop strategies or alternative approaches to mitigate risk if it occurs. Actively track risks – they may change over time.



The final discussion for Working Group 2 was if mission level requirements must be developed pre-milestone A in order to better define mission capability for use in the system development and test and evaluation processes. An output of the Capabilities Based Assessment is a list of capability gaps and Capability Requirements. From the stated Capability Requirements, mission level requirements and performance attributes may be derived and supported. Mission decomposition can be performed to develop use cases and concepts of operation. Remember to develop mission profiles and use cases for sustainment, for training, for logistics and maintenance. These activities result in a more thorough mission understanding which leads to better design, better cost estimates and opportunity to have an affordable acquisition. These inform the design and drive cost and affordability. A mission level requirements perspective also helps to ensure end-to-end mission needs are captured. All components and systems necessary to execute the mission need to be included the affordability analysis.

**Working Group 3, Post-Milestone A and the Remaining Life Cycle** – Working Group 3 discussed affordability analysis across the life cycle, post Milestone A. The acquisition process was designed to provide capability to the warfighter with little regard for cost. Adding work products to Post Milestone A activities to address O&S is needed in most cases and should be called out in contractor statements of work. There was lively dialog around the fact that not all acquisitions drive high O&S costs. Satellites and munitions were offered as examples of a potentially low percentage of O&S cost in relation to total life cycle cost (LCC). A tailoring of the “wall chart” based upon percentage of O&S to LCC would adjust the emphasis needed early to manage the risk of O&S based upon its contribution to life cycle cost. This would help change behavior by emphasizing the importance of considering O&S Post-Milestone A.

Model based visualization should be incorporated in contractor statements of work to improve development cycle time and affordability of development programs. It provides early insight into testability, manufacturability and sustainability. Additionally, discussions provided insight that operations and support Concept of Operations (CONOPS) were developed as part of AoA. Transitioning CONOPS to the contractor once an award is made will provide continuity and an evolution path for future phases of O&S analysis.

Working Group 3 also discussed affordability analysis across the life cycle, post Milestone A. Recommendations included: (1) Model based visualization should be incorporated in contractor statements of work to improve development cycle time and affordability of development programs by providing early insight into testability, manufacturability and sustainability; and (2) Operations and support Concept of Operations (CONOPS) were developed as part of AoA and should be transitioned to the contractor once an award is made to provide continuity and an evolution path for future phases of O&S analysis.

**Working Group 4, Affordability and Logistics / Sustainment Considerations** – The Working Group 4 discussions centered on logistics and sustainment considerations across the life cycle. When benchmarking, there is a need to consider not only the size and complexity of the system, but also the number of systems. The metrics used need to be appropriate for the level of decision maker – a fleet commander may find dollars per flight hour useful, but at a lower level the aggregation and underlying assumptions in such a metric can cause inappropriate decisions.

Other comments and recommendations were:

- Logisticians need a seat at the Milestone Decision Authority (MDA) decision table to raise the level of attention for sustainment





- A standard process and methodology would help with sustainment affordability
- Incentivizing optimizing across the enterprise is needed
- Leveraging supply chain innovation to manage sustainment costs
- Learning best practices at UPS, FedEx, Amazon, and others in the private sector
- Accountability for lifecycle costs
- Deriving better affordability metrics
- Relating resources to readiness for current systems

**Working Group 5, *Expanding the Affordability Definition and Trade Space*** – The Affordability Trade Space Working Group reinforced the need for dynamic and interactive visualization applications to be developed and presented to leadership instead of PowerPoint slides. These visualizations must enable leadership to interact within the entire trade space so individually they can identify what they feel is “the most affordable solution.” The goal would be to display multiple outcomes and parameters simultaneously while being interactive for decision makers.

### **THE BOTTOM LINE**

The MORS Affordability Analysis Workshop was timely, providing needed discussions from key leadership, organizations, and individuals. However, the matter should not end here. A small core group, perhaps the core of a new MORS Affordability Analysis Community of Practice, could be established to continue working with the government on the workshop recommendations discussed in this final report, particularly the ones listed here:

- Define affordability analysis contexts, including portfolios
- Develop an affordability analysis “how to manual”
- Specify organizational accountability across the full life cycle
- Establish sustainment cost targets
- Maintain and update an accountability trace for key decisions over time
- Tools and methodologies appear to be adequate – need standard processes and quality data
- Explore use of Cost as an Independent Variable (CAIV)
- Create dynamic and interactive visualizations to provide a better understanding of the affordability trade space

### **WORKSHOP RESULTS BRIEF COMMENTS**

A summary outbrief (Appendix G) was presented to senior leadership, as well as other groups. The highlights of their comments and recommendations are presented in the next sections.

**SENIOR LEADERSHIP** – There were two briefs to senior leadership and a MORS Sponsor review of the final report. For the briefs, one was to the workshop proponent (ASD(A)) and the other was to the Deputy J8; and for the review, the USMC MORS Sponsor reviewed the brief and draft final report.

Attending the workshop proponent outbrief were the ASD(A) Ms. McFarland, the Principal Assistant Secretary of Defense for Systems Engineering Ms. Kristen Baldwin, the OSD(ATL) Lead for Affordability Dr. Phil Anton, the Government Development Planning Working Group Lead Ms. Aileen Sedmak, the Government Acquisition Modeling & Simulation Working Group Lead Ms. Philomena Zimmerman, plus three others. During the briefing, the following comments and recommendations were made:



- Affordability Level and Portfolio Definitions
  - Static, pre-defined portfolios may not be able to be defined. Recommend crafting more dynamic portfolio definitions depending on the mission context understanding the decision that needs to be made. Then the systems included in the portfolio would have to provide rationale why the system meets the criteria to be included.
- Affordability Analysis “How To Manual”
  - As an affordability analysis “How To Manual” is developed, recommend reviewing the 1989 “Design to Cost” book by Jack Michaels.
  - The workshop participants recommended looking at least 30 years for affordability analyses. The workshop proponent stated that is already a mandate to look out 30 years. It was recommended to ensure better awareness among the user community.
  - The ASD(A) and OSD(ATL) Staff was already looking beyond point estimates to range estimates, calling it a “gray area.”
  - In the Additional Suggestions section of the outbrief, one of the working groups recommended seeing if the Cost as an Independent Variable (CAIV) process could be adapted for the affordability analysis process. The workshop proponent stated that Joint Staff is already doing this for JCIDS support at the JROC. It was recommended to work with J8 to ensure better awareness among the user community.
  - Recommend looking at the high-speed computer capabilities to determine they could be used in affordability analyses problems.
- Affordability Analysis Accountability
  - The workshop participants recommended having a logistician at the MDA Table. The workshop proponent stated that is already a mandate to have a logistician at the MDA table. It was recommended to ensure better awareness among the user community.
- Other Comments
  - The Government Development Planning Working Group can help provide the pre-Milestone A data for the “Post-Milestone A and the Remaining Life Cycle” Working Group’s Information Needed Table.
  - It was believed that doing affordability analysis required a different skill set then visualization of the results.

Attending the J8 outbrief were the Deputy J8 Ms. Lisa Disbrow, the Lead Civilian Analyst Dr. Tom Allen, and two members of the workshop planning committee: COL Doug Matty and LTC Lisa Daniels. During the briefing, the following comments and recommendations were made:

- Affordability Level and Portfolio Definitions
  - A DoD Instruction on joint capabilities was started but never completed that contained some example portfolios. It was recommended to review the draft document for portfolio examples.
- Affordability Analysis “How To Manual”
  - The Deputy J8 believed and affordability analysis “How To Manual” and starting thinking how they could enforce it.
  - The Deputy J8 recommended ensuring the qualitative aspect of affordability is included in the new process.



- The Deputy J8 recommended the new affordability analysis process not be focused on cost, but on the mission or value.
- The Deputy J8 recommended two pilot projects once the affordability analysis process is developed:
  - Something in the area where there is no established cause and effect, maybe something in the area of cyber warfare.
  - Operationalizing the reserve force, i.e., how much is affordable to keep active?
  - Also recommended was an historical example, such as the JSF, to determine how affordability could have changed the procurement path – i.e., was there a tipping point to make the program unaffordable?
- Affordability Analysis Linkages
  - The Deputy J8 mentioned that incentivizing bidding is a fundamental challenge to affordability linkages and there is a lack of discipline in contracts management.
- Other Comments
  - Another consideration was for the operations analyst should have an understanding of the requirements process and the recommendation was to attend the Requirement's Manager Training Course.
  - One recommendation was while the acquisition workforce is getting revamped was to consider more operations analysts working affordability analysis with a balance of civilian 1515 and military-coded operations analysts (e.g., for the Army the 49-coded officers).

The MORS Marine Corps Sponsor, Dr. George Akst, reviewed the draft final report and outbrief. The following comments and recommendations were made:

- Foundation Information
  - Affordability is NOT tantamount to cost-effectiveness or efficiency. As a result, affordability is not considered to be "being cost efficient in executing a program", or "assessing whether this capability – considering what it is going to cost (or is costing us) – provides sufficient value". Affordability is simply asking if it fits within future budget predictions or not. It was recommended to ensure the "little a" and "Big A" interpretations are initial interpretations in the final report, and to consider the above definition when the process is developed.
  - Recommend reviewing two of the best practices for accuracy of what was reported:
    - Was not aware that we traded off the sling loading of the JLTV. What I do recall is that we traded off the dual-sling load of two JLTVs, accepting only one sling-loaded truck. You may want to check this.
    - If I recall correctly, there is a lot of controversy about the 3DELRR program, in that the USMC G/ATOR program may provide a more cost-effective solution for the DoD. Again, might be worth checking into as a example to hold up for affordability (e.g., common solution across services may be more affordable from a DoD perspective).
- Affordability Analysis "How To Manual"
  - One of the analytically challenges questions is, "how do we figure out (i.e., project) what the future budget is going to be?" During the FYDP years, that can be pretty straightforward, but beyond that, it is not. Do we take the end year of the FYDP and



project straight out, with or without some real growth or inflation growth? Some say this is the way to do it. I say that if we look at historic expenditures, and the last year of the FYDP is way above the historical average (adjusting for inflation), then the above method may be somewhat optimistic. Even within the FYDP years, taking the out-year FYDP budgets as gospel does not jibe with reality -- base out-year budgets are almost always smaller than predicted 5 years earlier (of course, counterexamples to this involve unexpected wars). It was recommended to take this into account when developing the affordability process.

- Other Comments
  - In general, there is a lot of discussion in here that I would really ascribe to being cost-effectiveness (e.g., tweaking performance parameters to getting a cheaper, almost-as-effective system), rather than affordability.

**OTHER BRIEFS** – The brief was also presented two other times, one to the Washington Chapter of INFORMS (WINFORMS) and one during the first annual MORS Industry Showcase Day.

About 30 members attended the WINFORMS Briefing. During the briefing, the following comments and recommendations were made:

- Foundation Information
  - During the briefing, some of the audience believed there were three different sets of affordability analysis definitions: little a and Big A, strategic and tactical, and the actual definitions by level. It was recommended to stress that little a and Big A were the initial interpretations and that the strategic and tactical were background information before the definitions were developed. There were only two affordability analysis definitions, the two by level: portfolio and system.
- Affordability Analysis “How To Manual”
  - Given the portfolio and funding profile, considerations for affordability analysis process should include:
    - Should we pay for the system?
    - How much of it is needed?
    - When is it needed?
    - Should be an assessment of value and cost.
- Affordability Analysis Accountability
  - It was mentioned that there was no accountability identified in the affordability analysis definitions. It is recommended that the next steps include accountability for affordability and affordability analysis.

Over 60 people attended the workshop results briefing at the end of the MORS Industry Showcase Day. During the briefing, the following comments and recommendations were made:

- Affordability Analysis “How To Manual”
  - It was recommended that cost be considered a Key Performance Parameter (KPP) for any system development in an affordability analysis process. Many operations analysts do not pay attention to costs, but need to understand it.



- Other Comments
  - In the past, some organizations recommend new ideas without any concerns for the costs. It is recommended in the future for those that recommend new ideas become a stakeholder and be responsible for at least some of the costs.

Other comments and recommendations include:

- Affordability Analysis “How To Manual”
  - Increasing visibility of sustainment factors is vital to ensuring we deliver a program that meets Warfighter materiel readiness objectives with long-term affordability consideration. To facilitate a comprehensive review and provide the required information in a standardized format, these logisticians are to use the sustainment quad chart ([https://acc.dau.mil/adl/en-US/360876/file/49948/Sustainment%20Governance%20ATL%20Memo%20%20Quad%20Chart%20\(5%20Apr%2010\).pdf](https://acc.dau.mil/adl/en-US/360876/file/49948/Sustainment%20Governance%20ATL%20Memo%20%20Quad%20Chart%20(5%20Apr%2010).pdf)) to report the status of sustainment planning at Overarching Integrated Product Team and Defense Acquisition Board reviews.
  - Reporting begins at program initiation and continues through each subsequent milestone, the production decision, and at other reviews when directed."
  - The chart template and instructions will also be included in the Defense Acquisition Guidebook.
- Other Comments
  - After attending the brief, representatives from SAS JMP recommended JMP for dynamic visualizations of the affordability analysis results. Using JMP, a model can be created to do “what if” questions with various methods of visualization.

## **NEXT STEPS**

The recommended next steps are to establish a team, review current information, complete the workshop major recommendations, and test the process on a couple of pilot programs.

**STEP 1: ESTABLISH THE TEAM** – The first step would be to establish the team, a core team and an extended team. The core team would be a small team doing the actual work. This team would consist of some government members (OSD-ATL, J8, etc.) and some MORSians. The extended team would be a larger team that would conduct the peer reviews of the core team’s products.

**STEP 2: REVIEW CURRENT INFORMATION** – Once formed, the core team will review current information, such as the established portfolios and levels, the Defense Acquisition Guide Affordability section, the OSD(ATL) Affordability Process, the Sustainment Quad Chart, the MORS Affordability Analysis Workshop Final Report and Recommendations, and Jack Michael’s book “Design to Cost.”

**STEP 3: COMPLETE THE WORKSHOP MAJOR RECOMMENDATIONS** – After a review of the current affordability analysis information, the core team will develop definitions for portfolios and level and then develop an affordability analysis “How to Manual” with accountability and traceability between data and decisions. When the products are developed by the core team, the extended team will conduct a peer review of them. After updating the products based on the peer reviews (if necessary), the products will be presented to the appropriate government leadership for approval.



**STEP 4: TEST THE PROCESS** – Once approved, the government will test the new process and definitions on a couple of pilot projects, incorporating any lessons learned into the process.





# Affordability Analysis: How Do We Do It?

1-4 October 2012 | Lockheed Martin Global Vision Center, Arlington, VA

## APPENDIX A – Acronyms

3DELRR	Three-Dimensional Expeditionary Long-Range Radar
AF	Air Force
Afford	Affordability
ALU	Army Logistics University
AM	Morning
AMSWG	Acquisition Modeling & Simulation Working Group
AoA	Analysis of Alternatives
ASD(A)	Assistant Secretary of Defense (Acquisition)
B	Billion
BBP	Better Buying Power
Brig Gen	Brigadier General
C2	Command & Control
CAIV	Cost as an Independent Variable
CAPE	Cost Assessment and Program Evaluation
CBA	Capabilities Based Assessment
CBP	Capabilities Based Planning
CDD	Capabilities Development Document
COEA	Cost & Operational Effectiveness Analysis
Col	Colonel
CONOPS	Concept of Operations
DAB	Defense Acquisition Board
DARPA	Defense Acquisition Requirement Planning Agency
DAU	Defense Acquisition University
DoD	Department of Defense
DoDI	Department of Defense Instruction
DOE	Design of Experiments
DP	Development Planning
DPP	Defense Planning Projection
Dr.	Doctor
DRDC	Defence Research and Development Canada
Dtd	Dated
EMD	Engineering & Manufacturing Development



FBC	Fully Burdened Costs
FFRDC	Federally Funded Research & Development Center
FS	Fellow of the Society (MORS)
FYDP	Future Years Defense Plan
Govt	Government
GVC	Global Vision Center
HQMC	Headquarters Marine Corps
ICD	Initial Capabilities Document
IDA	Institute for Defense Analyses
INCOSE	International Council on Systems Engineering
INFORMS	Institute for Operations Research and Management Sciences
ISMOR	International Symposium on Military Operational Research
ISR	Intelligence, Surveillance & Reconnaissance
JCAs	Joint Capability Areas
JCIDS	Joint Capabilities Integration and Development System
JHU/APL	The Johns Hopkins University Applied Physics Laboratory
JLTV	Joint Light Tactical Vehicle
JROC	Joint Requirements Oversight Council
JSF	Joint Strike Fighter
KPP	Key Performance Parameter
KSA	Key Systems Attribute
LCC	Life Cycle Costs
LLC	Limited Liability Corporation
LTC	Lieutenant Colonel
MAS	Military Applications Society
MDA	Milestone Decision Authority
MDD	Material Development Decision
MORS	Military Operations Research Society
MOSA	Modular Open Systems Architecture
Mr.	Mister
MS	Milestone
N	North
NASA	National Aeronautics & Space Administration
NATO	North Atlantic Treaty Organization
NDIA SE	National Defense Industrial Association Systems Engineering (Division)
NPS	Naval Postgraduate School
O&M	Operations & Maintenance
O&S	Operations & Support
OASD(SE)	Office of the Assistant Secretary of Defense for Systems Engineering
OIPT	Overarching Integrated Product Teams
OMB	Office of Management and Budget
ORSA	Operations Research Systems Analyst



OSD	Office of the Secretary of Defense
OSD/ATL	Under Secretary of Defense / Acquisition Technology and Logistics
OT&E	Operational Test & Evaluation
P&R	Programs & Research
PA&E	Program Analysis & Evaluation
PDASD(SE)	Principal Deputy Assistant Secretary of Defense for Systems Engineering
PM	Afternoon
RCT	Requirements Correlation Table
ROI	Return on Investment
SCEA	Society for Cost Estimation and Analysis
SME	Subject Matter Expert
SSA	Support to Strategic Analysis
ST	Street
STE	Suite
T&E	Test & Evaluation
TOA	Total Obligation Authority
TOC	Total Ownership Cost
TOR	Terms of Reference
TRADOC	Training Analysis & Doctrine Command
UK	United Kingdom
US	United States
USA	United States Army
USAF	United States Air Force
USC	University of Southern California
USCG	United States Coast Guard
USD/ATL	Under Secretary of Defense / Acquisition Technology and Logistics
USMC	United States Marine Corps
USN	United States Navy
VA	Virginia
WBS	Work Breakdown Schedule
WG	Working Group



**MORS Special Meeting:**

## **Affordability Analysis: How Do We Do It?**

**1-4 October 2012 | Lockheed Martin Global Vision Center, Arlington, VA**

**Workshop Security Level: Unclassified**

# **APPENDIX B – Terms of Reference**

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# 1. Overview

Given the current budget crisis and complex, uncertain security environment, the Department of Defense is very focused on “affordability.” When he was the Under Secretary of Defense for Acquisition Technology & Logistics (USD/ATL), the current Deputy Secretary of Defense defined affordability as “cost effective capability.”

Affordability has thus been defined, but discussions at the recent MORS Special Meeting on Risk, Trade Space and Analytics in Acquisition, in the Development Planning (DP) Working Group, discovered that affordability analysis was ill-defined – i.e., for those organizations that defined it, there is not a consistent definition for affordability analysis across the Department of Defense. The working group recommended developing and formalizing affordability analysis processes, including recognizing the difference between cost and affordability analyses, and that affordability analysis should include mission-based, portfolio-based, and capability-based analyses.

The results of this Special Meeting will contribute to increasing the DoD community awareness and understanding of affordability analysis. The workshop will consist of a series of background presentations Monday afternoon October 1st, plenary keynotes and panel discussions Tuesday morning October 2nd, working group sessions Tuesday afternoon October 2nd through Thursday morning October 4th, and outbriefs Thursday afternoon, October 4th. The five working groups are:

- WG 1: People, Authorities, Organizations, Methods and Tools
- WG 2: Development Planning and the Early Life Cycle
- WG 3: Post-Milestone A and the Remaining Life Cycle
- WG 4: Affordability and Logistics / Sustainment Considerations
- WG 5: Expanding the Affordability Definition and Trade Space: Providing a More Holistic Life Cycle Cost and Operational Outcomes View

# 2. Introduction

Some believe affordability is overrated and already over-subscribed, rapidly overtaken by the large impending reductions in the growth of the defense budget. The perception is that the important decisions are being made not on the basis of individual systems importance (value) and cost but on more mundane political factors (e.g., productivity distributed throughout congressional districts). However, per the USD/ATL directives on affordability, others believe DoD wants to move away from what is described as selecting programs for political factors to understanding affordability analyses including should-costs, total ownership costs, and making some affordability considerations across the entire life cycle.

Additionally, the National Defense Industrial Association Systems Engineering (NDIA SE) Division and the Industrial Council of Systems Engineering (INCOSE) have both established Affordability Working Groups. They have spent time determining what affordability is and how it relates to government and industry, but they have not considered the rationale behind making affordability-related decisions – i.e., the analysis necessary to make these decisions.

As a result, MORS and these two sister societies propose to work together in addressing the government's concerns about affordability analysis, including discussing:

What is the difference between cost-benefit analyses and affordability analyses? Is there a difference? If so, what is the state of the practice of affordability analyses? What are the key issues and shortfalls? What is the guidance for best principles and practices? What area(s) do we need to understand better than the current knowledge levels? What area(s) do we need to prioritize higher to understand sooner?

This Workshop will research and examine the above questions and comments, as well as many others, in how analytical rigor can be applied in affordability analyses, including ways to address affordability in acquisition.

### 3. Background

#### a. Background –

There have been several memos from the previous USD/ATL on “Should-Cost, Will-Cost and Affordability.” In his 28 June 2010, he introduces the three terms. In his 3 November 2010 memo, he realized, “... some understandable confusion exists as to how to implement both ‘should-cost’ and ‘affordability as a requirement’...” He followed up recently in his 24 August 2011 memo that both “should-cost” and “affordability as a requirement” must be implemented in programs, describing how in these last two memos.

“Affordability as a requirement directs that we establish quantified goals for unit production cost and sustainment costs for our products.... We should set these goals early and use them to drive design trades and choices about affordable priorities. Affordability analysis is based on the budgets we expect to have for the product over its life cycle and provides a design constraint on the product we will build, procure and sustain.”

“Should-cost asks us consciously to do something different. It asks us to continuously fight to lower all our costs, whenever that makes sense. Should-cost is a tool to manage all costs throughout the life cycle, and it operates in parallel with the effort to constrain our requirements appetites in order to control the final product unit and sustainment costs.... Should-cost does not mean trading away the long-term value of sound design practices and disciplined engineering management for short-term gain; it does mean eliminating non-value added overhead and unnecessary reporting requirements.”

#### b. Other Affordability-Related Definitions –

Given the USD/ATL definition of “cost-effective capability” as a foundation, several organizations have restated the very concise, elegant affordability definition, including the Office of the Secretary of Defense Cost Analysis and Performance Evaluation (OSD-CAPE) Cost Estimating Guide, and the Defense Acquisition Guidebook, and the Affordability Working Groups of the National Defense Industrial Association (NDIA) and the International Council of Systems Engineering (INCOSE). These definitions are as follows.

From the OSD CAPE 2007 Cost Estimating Guide:

*Affordability can be defined as the degree to which the life-cycle cost of an acquisition program is in consonance with the long-range modernization, force structure, and manpower plans of the individual DoD Components (military departments and defense agencies), as well as for the Department as a whole. For major defense acquisition programs, affordability assessments are required at Milestones B and C. The purpose of the assessment is for the DoD Component to demonstrate that the program's projected funding and manpower requirements are realistic and achievable, in the context of the DoD Component's overall long-range modernization plan. Further information on affordability assessments may be found in the Defense Acquisition Guidebook (ref c), Chapter 3. Affordability assessments consider not only development and investment costs, but O&S costs as well. In addition, manpower (expressed in military end-strength and civilian full-time equivalents) is treated as a resource in affordability assessments, to determine if the program's manpower requirements are achievable within the Component's overall long-range manpower constraints.*



## Defense Acquisition Guidebook:

*Affordability can be defined as the degree to which the life-cycle cost of an acquisition program is in consonance with the long-range modernization, force structure, and manpower plans of the individual DoD Components, as well as for the Department as a whole.” Section 3.2.2. Affordability Assessments: Assessments for all acquisition programs at Milestones B and C. The purpose of the assessment is to demonstrate that the program's projected funding and manpower requirements are realistic and achievable, in the context of the DoD Component's overall long-range modernization plan. Normally, this assessment requires a DoD Component (or even DoD-wide) corporate perspective, and so the Affordability Assessment should not be prepared by the program manager. Rather, the assessment typically should be conducted by resource analysts in the DoD Component headquarters or a supporting organization, or alternatively in the OSD staff. For a joint program, the Affordability Assessment may be prepared by the lead DoD Component, although it may be necessary to display separate analyses for each DoD Component, as appropriate. The approach to the Affordability Assessment can vary, depending on the nature of the program and its milestone decision. This version of the Guidebook offers two possible approaches. The first approach involves analysis of the program's projected annual funding. The second approach involves simple unit-cost comparisons, calculated on a normalized life-cycle cost basis, between the current program and one or more appropriate predecessor programs.*

The OSD CAPE Cost Estimating Guide and the Defense Acquisition Guidebook affordability definitions primarily focus on what systems cost, and whether DoD can afford it. These sources do not discuss the potential cost of systems with improved design, production, etc., and may focus too much on acquisition costs and meeting system-level KPPs, rather than operations and sustainment costs, which make up roughly 70% of the life cycle cost.

NDIA's is DoD-focused:

*Affordability is the practice of ensuring program success through the balancing of system performance (KPPs), Total Ownership Cost, and schedule constraints while satisfying mission needs in concert with long-range investment, and force structure plans of the DoD.*

Using the NDIA as a foundation, the INCOSE definition is both Commercial and DoD-focused:

*Affordability is the balance of system performance, cost and schedule constraints over the system life while satisfying mission needs in concert with strategic investment and organizational needs.*

### c. Support to Strategic Analysis (SSA) –

The Support to Strategic Analysis (SSA) provides a validated context for evaluating system capability and performance in an operational environment. The performance of different systems can be compared in the SSA context, enabling analytically-based system acquisition decisions and requirements generation. However, no analogous context for evaluating and comparing life cycle cost exists, and estimation methods can be ad hoc, subjective, and based on widely varied system scopes. This lack of standards and context prevents consistent evaluation of alternate system solutions proposed by different parties, and thus complicates development of a clear understanding of the relationships between cost, performance, and risk of defense systems. The DoD acquisition community and industrial base would greatly benefit for an Affordability analysis agenda that establishes a framework for understanding and comparing system life cycle cost. This agenda would address the following questions and issues:

- Where are the scope boundaries on life cycle cost? It should consider lot size, cradle to grave system costs, support equipment and logistics, interfaces with existing and future systems, personnel training and O&M costs, etc. It should define limits for inclusion of cost impact on interoperating and enabling systems, such as platforms, ISR, C2, etc.

- What duration, events, deployment profile, planned improvements, and other attributes comprise the expected life cycle? While the life cycle will vary greatly among systems, a tailorable framework of attributes can enable construction of a life cycle profile that can be developed until subject matter experts validate it as sufficient for characterizing life cycle cost. The profiles should consist of attribute ranges when possible, rather than point parameters, to account for uncertainty in the system life cycle.
- What decomposition of life cycle cost can simplify evaluation and comparison of affordability? Which components of life cycle costs tend to generate unaffordability? What are the technology risks associated with affordability? Obvious examples include unaffordable development costs for technically extreme systems and excessive material costs, but other aspects, such as unusual maintenance requirements, warrant examination.
- What analytical techniques are best suited to evaluate life cycle cost within the framework? While computation of cost at the edges of the expected life cycle envelope is an excellent first step, sensitivity analysis and optimization should be explored.

#### d. Potential Affordability Analysis Approaches –

Best practices for conducting affordability analyses consistently across DoD are needed. One possible simple approach could be:

- Clearly state what needs to be done (i.e., define the required capability)
- Establish a baseline capability cost, typically using existing methods
- Evaluate whether DoD actually needs to invest in the capability, and if so, determine whether the capability is affordable (cost-effective) or not (either the money is not available or it isn't worth the money, i.e., not cost-effective)

Since other potential approaches exist and affordability analysis may be very complex, this special meeting will examine current practices and aim to establish a foundation for defining affordability analysis and affordability requirements / targets for DoD Acquisitions.

#### e. Workshop Justification –

Affordability has thus been defined, but discussions at the recent MORS Special Meeting on Risk, Trade Space and Analytics in Acquisition, in the Development Planning (DP) Working Group, discovered that affordability analysis was ill-defined – i.e., for those organizations that defined it, there is not a consistent definition for affordability analysis across the Department of Defense. The working group recommended developing and formalizing affordability analysis processes for DP, including recognizing the difference between cost and affordability analyses, and that affordability analysis should include mission-based, portfolio-based, and capability-based analyses.

The results of this Special Meeting will contribute to increasing the DoD community awareness and understanding of affordability analysis. The MORS Sponsors endorsed and approved the topic at the January Sponsor's Luncheon.

## 4. Goals and Objectives

#### a. Overall Objectives –

Every DoD organization is involved in affordability – either directly supporting the analysis or indirectly providing the data to support the analysis. The analytic community needs to support the national security environment with analytical rigor as a key component of affordability activities. The community should play a leadership role in creating/refining these needed metrics, processes, methodologies, models and simulations. The community should share efforts, successes and failures in the key capabilities.

This special meeting will provide a forum for discussing Defense Department (i.e., Army, Navy, Marine Corps, Air Force and Joint) approaches to affordability analyses throughout the life cycle. It will provide an opportunity for operators, engineers, decision makers, academicians, and government / military / civilian operations research analysts to examine topics, methodologies, analyses, and innovations pertinent to all aspects of analysis for affordability as a function of total ownership cost and system performance.

The overall objectives of this special meeting on *Affordability Analysis: How Do We Do It?* will be to provide an assessment and a roadmap to revitalize the state of analytical rigor being applied to the practice and to recommend priorities for any initiatives identified. Some specific objectives for the Working Groups include:

- Determining the difference between cost analysis and affordability analysis
- Describing the state of practice for affordability analysis (i.e., best practices, knowledge level, cultural issues, future challenges, etc.)
- Recommending the operations analysis needs to conduct affordability analyses (i.e., skills, tools, techniques, measures, relationships, etc.)
- Examining various considerations for affordability analyses across the life cycle (e.g., mission-based / portfolio-based / capability-based analyses; simplification techniques; trade space; mission / technology changes; and risk / uncertainty)
- Discuss the affordability of a force structure in a mission context. Can we afford the capability?

b. Other issues the working groups will consider –

For each of the overall objectives, there are several issues each working group will consider. They are:

- What is the state of the practice of affordability analyses? Identifying key issues and shortfalls –
  - What is the guidance for best principles and practices relating to affordability analyses?
  - What area(s) do we need to understand better than the current knowledge levels?
  - What area(s) do we need to prioritize higher to understand sooner?
  - What are the operations analysis competency development and knowledge sharing concerns?
  - What are the cultural issues?
  - What areas do the current affordability cost targets cover? Who are they generated by? What areas are not covered?
  - Affordability Analysis is more broad than just for weapons systems. What about other areas, such as Force Structure analyses, etc.?
- What are the examples of how operations analysis analytical rigor has been applied to support affordability analyses? What are the future challenges?
- What is needed from the operations analyst to conduct affordability analyses?
  - What is the skill set needed for operations analysts conducting affordability analyses?
  - What are the tools, techniques, methodologies and measures for affordability analyses across the life cycle?
  - What is/should be the context and relationships between the Operations Analysis community with the cross-functional team (e.g., user, acquisition, resource, requirements, operations analysts, testers, programmers, cost analysts, system engineers, operators, etc.) and the stakeholder (those organizations working with affordability) needs?
- What should be considered for affordability analyses across the life cycle?
  - How should affordability be addressed in acquisition? How can affordability be communicated more broadly? How can acquisition decisions be tied to affordability?
  - How are affordability cost targets included?

- What decomposition of life cycle costs can simplify evaluation and comparison of affordability across the life cycle?
  - What is the trade space? What are the best methods and practices to examine the trade space?
  - How do you factor in mission and technology changes?
  - How should risk and uncertainty be included? What is affordability risk?
- Can a quantitative relationship between capability and cost be defined in order to help achieve affordability?
    - Should analyses include high-level mission-based, portfolio-based and capability-based analyses? If so, how?
    - Can the requirements process and the evaluation process be improved to address mission capability vice system performance?
    - How can the operational environment used in the requirements process (scenarios, threats, etc.) be linked or made consistent with the evaluation process?
    - Can mission capability level metrics be developed in the requirements process and used in the evaluation process to better address mission accomplishment

## 5. Approach

- a. 1<sup>st</sup> Afternoon Before the main Special Meeting – Workshop Kick-Off – From 1300 to 1700 on the afternoon before the special meeting, a series of foundation briefs will be presented for those attendees who arrive early. The Goal is to prepare the audience before starting the workshop.
- b. 2<sup>nd</sup> Day Morning – Mini-Symposium – The meeting will commence with a mini-symposium format that will include operational based discussions as well as progress to date. The purpose of this portion is to bring all participants up to speed on the state of the practice and frame the analytical challenges and issues for the working groups. Included will be a keynote presentation(s) and potential panel discussions.
- c. 2<sup>nd</sup> Day Afternoon, 3<sup>rd</sup> Day All Day & 4<sup>th</sup> Day Morning – Workshop – The Mini-Symposium will be followed by a two-day workshop where participants will meet in working groups to further examine specific topics, including discussing the overarching issues of the Workshop. Working groups will prepare a report on their activities to present to other workshop participants at the last session of the workshop (4<sup>th</sup> Day Afternoon). To focus the discussion in each of the working groups, a select group of people will be requested to prepare and present papers. The workshop attendees will be organized into five working groups plus a synthesis group. The working group structure is detailed below.
  - (1) Working Group Overview – Affordability is all about ensuring that the costs of a program fit within the DoD budget and more specifically, the service budgets where the trades are usually made. Thus a program is viewed in this context early in its life cycle (WG 2), during acquisition (roughly WG 3) and after it is fielded (WG4). At each of these three stages in the life cycle an affordability evaluation is made based on projected budgets. Trades are conducted (e.g., reduce buy, modify design, use less, etc) to determine if a system is deemed unaffordable in the context of the entire program. This leads to WG5 which has the “portfolio” perspective – in a sense it is the integrator of the information provided by WGs 2-4.
  - (2) WG 1: *People, Authorities, Organizations, Methods and Tools* – WG 1 will identify the state of the art in affordability analysis, and highlight team composition, affordability authorities, tools, and methods that contribute to good affordability analysis. Team members may include Operations Analysts, Cost Analysts, System Engineers, supply chain experts, and others. The following questions will be discussed in this working group as well as others associated with affordability analyses people, methodologies and tools.

- (a) What are the roles and responsibilities overall through the life cycle?
  - (b) What are the organizations that should be involved? Are there any differences in people, methods and tools pre-Milestone A compared to after Milestone A?
  - (c) What are the necessary skills?
  - (d) What techniques and tools are used? Are they quantitative, qualitative or both?
  - (e) What methodologies are used to analyze the data for affordability analyses?
  - (f) How will data/information and historical/knowledge databases be used?
  - (g) What analytical techniques are best suited to evaluate life cycle costs related to affordability analyses?
  - (h) Can continuous integration using system life cycle V&V models be accomplished?
  - (i) What are the “right” measures?
  - (j) What tools and techniques are used to report the results?
  - (k) Many affordability definitions start with, “The degree to which ....” How can we measure “the degree to which ....”?
  - (l) Who are the affordability authorities that need to be aware of the affordability analyses?
- (3) *WG 2: Development Planning and the Early Life Cycle* – WG 2 will identify the state of the art in affordability analysis during the Development Planning Phase prior to Milestone A. Team members may include Operations Analysts, Government Development Planning representatives, Industry Development Planning representatives, and others. The following questions will be discussed in this working group as well as others associated with affordability analyses during development planning.
- (a) How does affordability analysis support the Development Planning Process?
  - (b) Prior to Milestone A, what is required for a first-cut affordability analysis?
  - (c) Should it include high-level mission-based, portfolio-based, and capability-based analyses?
  - (d) When is it needed: pre-MDD, pre-Milestone A, both?
  - (e) What decomposition of life cycle costs can simplify evaluation and comparison of affordability pre-Milestone A?
  - (f) Which components of life cycle costs tend to generate unaffordability pre-Milestone A?
  - (g) What are the roles and responsibilities during this phase of the life cycle?
  - (h) What are the key decision made during this timeframe that are key to affordability (i.e., what factors prior to Milestone A are most important)?
  - (i) How do we adequately consider Total Ownership Cost prior to Milestone A and consider both the system-of-interest and the enabling systems?
  - (j) How should the affordability analysis address uncertainty and different types of risk?
  - (k) Pre-Milestone A, can mission level requirements be developed that better define mission capability for use in system development and T&E processes?
    - How can requirements be more capability based instead of Service platform based?
    - How can the requirements process and platform evaluation process be better integrated or linked?
    - Can a methodology be developed for quantifying the relationship between “capability” and “cost” to achieve “affordability”?
    - Is there a more consistent approach to the CBA, AoA and T&E?
    - How can metrics, scenarios, etc., used in CBAs and AoAs be made more applicable in system development and testing?

NOTE: WG 2 Objective “k” was added to start discussions for a potential future MORs Special Meeting relating AoAs, JCIDs and T&E to affordability. With the number of overall objectives and other WG 2-specific objectives (i.e., “a” through “j” above) needed to be discussed in only eight working group sessions, only one-half to one session will be devoted to WG 2 Objective “k”.



(4) *WG 3: Post-Milestone A and the Remaining Life Cycle* – WG 3 will identify the state of the art in affordability analysis after Milestone A. Per the USD/ATL memo on “Should-Cost and Affordability” dated 24 August 2011, “the emphasis prior to Milestone B should be on defining and achieving affordability targets. Past this point, the emphasis shifts to defining and achieving should-cost estimates.” Team members may include operations analysts, cost analysts, acquisition representatives, requirements representatives, operators, and others. The following questions will be discussed in this working group as well as others associated with affordability analyses during the remaining life cycle after Milestone A.

- (a) After Milestone A, what is the scope of affordability and what factors are most important?
- (b) What information is available to conduct affordability analyses; should-cost incentives?
- (c) Can more detailed mission-based, portfolio-based, and capability-based analyses be conducted to support a higher fidelity affordability analyses?
- (d) What are the scope boundaries on life cycle costs related to affordability analyses?
- (e) What are the roles and responsibilities during this phase of the life cycle?
- (f) How do we adequately consider Total Ownership Cost and consider both the system-of-interest, other systems that integrate, and the enabling systems?
- (g) Mission needs evolve over time; how do we account for this fact and still keep our design affordable?
- (h) How do we time decisions to allow latest insight and technology?
- (i) How do we manage customer expectations that at any time in the development cycle, the baseline can be changed to embrace cheaper – i.e., more affordable – alternatives?
- (j) What decomposition of life cycle costs can simplify evaluation and comparison of affordability post-Milestone A?
- (k) Which components of life cycle costs tend to generate unaffordability post-Milestone A?
- (l) How should the affordability analysis address uncertainty and different types of risk post-Milestone A?
- (m) Are there differences comparing the work from Milestone A to Milestone B to the work Milestone B and beyond?
- (n) How are the assumptions developed pre-Milestone A maintained / adjusted through the life cycle?
- (o) After Milestone A, can the quantitative relationship between capability and cost developed in the requirements process be used to analyze the impact of DT&E effectiveness and suitability results on mission capability?
  - Can that relationship be used to assess the effect of not meeting or exceeding a threshold?
    - What are the cost implications?
  - Are scenarios and metrics used in development and T&E consistent with the CBA and AoA?
  - What is the impact of changes in threat capability?

NOTE: WG 3 Objective “o” was added to start discussions for a potential future MORS Special Meeting relating AoAs, JCIDs and T&E to affordability. With the number of overall objectives and other WG 3-specific objectives (i.e., “a” through “n” above) needed to be discussed in only eight working group sessions, only one-half to one session will be devoted to WG 3 Objective “o”.

(5) *WG 4: Affordability and Logistics / Sustainment Considerations* – Logistics and sustainment are huge cost drivers. WG 4 will identify the state of the art in affordability analysis as related to logistics and sustainment. Team members may include operations analysts, cost analysts, logistics analysts, acquisition representatives, requirements representatives, operators, and others. The following questions will be discussed in this working group as well as others associated with affordability analyses and logistics / sustainment considerations.



- (a) What needs to be considered to address the logistics and sustainment, as well as manufacturing and supply chain, costs across the life cycle related to affordability analyses?
  - (b) How do uncertainty and the differences in sustainment strategies impact affordability?
  - (c) Are there any strategies that are particularly beneficial from an affordability perspective?
  - (d) The system lifecycle costs imply that we have insight into Total Ownership Cost (TOC).
  - (e) When we look at cost models and practices in use today, what is the current state of the practices adequate to address the TOC for logistics and sustainment related to affordability analyses?
  - (f) What are the logistics and sustainment-related cost models? Are they useable for affordability analyses across the life cycle? If so, how? If not, why not?
  - (g) What are the existing Cost Metadata Standards/Specifications that will support credible and consistent Operations and Sustainment Cost estimations? Is there a need for them? How does this help affordability analyses?
  - (h) What is the cost of sustaining an affordable force structure?
  - (i) What about the affordability of non-life cycle sustainment capabilities?
- (6) *WG 5: Expanding the Affordability Definition and Trade Space: Providing a More Holistic Life Cycle Cost and Operational Outcomes View* – WG 5 has the “portfolio” perspective – in a sense it is the integrator of the information provided by WGs 2-4. WG 5 will identify the state of the art in affordability analysis and the associated trade spaces. Team members may include operations analysts, cost analysts, acquisition representatives, requirements representatives, operators, and others. The following questions will be discussed in this working group as well as others associated with affordability analyses and the associated trade spaces.
- (a) What are the best methods and practices to examine the trade space associated with affordability with respect to readiness and capability?
  - (b) What is the impact of the capability on the operational outcome and at what total cost?
  - (c) How can we ensure we have an affordable solution including understanding what risks we are accepting in terms of meeting desired performance outcomes?
  - (d) How can we increase operational capabilities while decreasing TOC over time?
  - (e) How can we capture and embrace system complexity (robust trade space) while decreasing complexity of the design process itself?
  - (f) How can we best represent risk / uncertainty associated with any of our assumptions?
  - (g) The trade space is dynamic. Things that would have been deemed affordable 15 years ago are now becoming unaffordable because of fundamental changes in infrastructure, such as skyrocketing cost of DoD Health Care, etc. How can we account for a dynamic trade space?
  - (h) What about balancing? If we are considering investing or purchasing another capability, we must balance its cost and benefits with ALL the things in our current portfolio and what other potential things we could purchase currently. For a new Capability X (or System or Force Structure Y), what current and future “things” must we forego or obtain in smaller quantities in order to obtain this? And what conditions in the future might influence that decision? One potential idea is that we may have to do sensitivity analysis on future conditions and their effects on all “variable” capabilities.
  - (i) Can we afford the ability to perform the mission? Can we afford the mission?
- (6) *Synthesis Group* – The synthesis group will bring together the work of the five working groups and develop overall assessment and recommendations for the community.

## 6. Agenda

### Day/Time Activity

#### Monday, 1 October 2012

1000 Registration for Workshop Kick-Off Attendees  
1330 Workshop Kick-Off Welcome  
1335 Workshop Expectations: Workshop & WG Chairs  
1405 The Foundation: Terminology Overview  
1445 Break  
1500 The Guidance: "Better Buying Power" Memo Overviews  
1545 The Opportunity: Affordability Thinking  
1645 Workshop Kick-Off Wrap-up: Workshop Chair  
1700 End of Kick-Off Session  
1700 Working Group Chair and Co-Chair Warm-Up Session

#### Tuesday, 2 October 2012

0700 Registration and Continental Breakfast  
0800 MORS President's Welcome  
0805 Workshop Overview  
0815 Keynote Presentations  
    > Government Keynote: The Honorable Katrina G. McFarland, Assistant Secretary of Defense for Acquisition  
    > Industry Keynote: Dr. Ray O Johnson, Senior Vice President and Chief Technology Officer, Lockheed Martin Corporation  
1015 Break  
1040 Plenary Panel Discussions (10 minutes each; 30 minutes Q&A)  
    > Members: OSD(ATL), J8 JCIDS/CBAs, OSD(CAPE) CAIG, Service AoA, NDIA Affordability Working Group, INCOSE Affordability Working Group  
1210 Lunch  
1240 Lunch Presentation: ISMOR Affordability Overview  
1330 Working Group Session #1  
1500 Break  
1530 Working Group Session #2  
1630 Synthesis Group Session  
1700 End Working Group Session #2  
1700-1830 Mixer

#### Wednesday, 3 October 2012

0715 Continental Breakfast  
0800 Working Group Session #3  
0945 Break  
1015 Working Group Session #4  
1200 Lunch  
1230 Optional Working Group Discussions / Synthesis Group Session  
1300 Working Group Session #5  
1445 Break  
1515 Working Group Session #6  
1700 Synthesis Group Session

## Thursday, 4 October 2012

0715 Continental Breakfast  
0800 Working Group Session #7  
0945 Break  
1015 Working Group Session #8  
1015 Synthesis Group Discussions with Workshop Participants  
1200 Lunch  
1245 Optional Working Group Discussions / Synthesis Group Session  
1330 Working Group Outbriefs: WG 1, 2 & 3  
1430 Break  
1500 Working Group Outbriefs: WG 4, 5 & Synthesis  
1600 Workshop Wrap-Up  
1700 Adjourn Workshop (for all but the Chairs)

## Friday, 5 October 2012

0800 Working Group Chairs complete Working Group Annotated Briefings  
1200 Adjourn Workshop (for Chairs)

The tentative utilization for the working group sessions will be:

- (1) Working Group Session # 1 – Kickoff: Introduction, agenda, issues & goals; and provide context to orient WG participants for discussion and debate
- (2) Working Group Session # 2 – Technical Papers / Discussion Session # 1
- (3) Working Group Session # 3 – Technical Papers / Discussion Session # 2
- (4) Working Group Session # 4 – Overarching objectives (discuss cost analysis/ affordability analysis definitions)
- (5) Day 2 Optional Working Group Discussions – After lunch (Consider: Speaker to address frontier issues on WG topic)
- (6) Working Group Session # 5 – Overarching objectives discussion
- (7) Working Group Session # 6 – WG objectives discussion (including additional objective on AoAs, JCIDs and T&E related to affordability for WGs 2 & 3)
- (8) Working Group Session # 7 – WG objectives discussion
- (9) Working Group Session # 8 – Refine ideas, arguments, capture WG debate, etc.

## 7. Attendees –

- a. Attendees will include invited experts from OSD, all Services, the Joint Staff, University Affiliated Research Centers, Federally Funded Research and Development Centers, operational commanders, DoD contractors, Department of Homeland Security, US Northern Command, and others, including representatives from our Allied / Coalition Analytical Communities. Workshop chairs will control membership of their sessions in conjunction with the Organizing Committee. Attendance will be limited to 200 people.
- b. Working Groups (WGs) will be led by a Chair with one to three Co-Chairs. This leadership group will be comprised of all MORSians or a combination of MORSians and Subject Matter Experts (SMEs). The responsibilities of this team include:

(1) Chair –

- (a) Dynamic individual that is a SME in the WG topic
- (b) Solicits analysts and operators in the field to participate in the WG
- (c) Guides the WG during the Workshop
- (d) Challenged to provide the “substance” of the special meeting WG
- (e) Develops the WG’s final product

(2) Co-Chair –

- (a) Individual interested in WG topic
- (b) Assists Chair in WG membership
- (c) Provides perspective during Workshop
- (d) Assist Chair as Chair requests
- (e) One Co-Chair could be selected as the WG recorder, to capture discussion highlights and include them in the WG's Outbrief

- c. Another key group of individuals during the Workshop is the Synthesis Group. This group will provide representation to each of the WGs and assist the Workshop Chairs consolidate the working group results and develop overall assessment/recommendations from the analysis community for the individual service operations research analysts to consider.

## 8. Products

Several products will be generated from the workshop:

- An Executive Summary in the form of a text document and a scripted briefing for the MORS Sponsors addressing the workshop objectives, findings, conclusions and recommendations will be offered within 30 days.
- A proceedings document containing summaries of all sessions and annotated copies of appropriate briefing slides and presentations.
- An article summarizing the meeting and its findings will be produced and submitted to *PHALANX* in time for the next deadline after the meeting.
- A general session presentation will be made at the 81<sup>st</sup> MORSS.

## 9. Milestone Table

See the *Affordability Analysis: How Do We Do It?* Plan of Actions & Milestones

## 10. Proponent

Assistant Secretary of Defense for Acquisition

## 11. Planning and Organizing Committee

### Workshop

Industry Co-Chairs: Kirk Michealson, LM Fellow, Lockheed Martin  
Jack Keane, FS, The Johns Hopkins University Applied Physics Laboratory  
Government Co-Chair: LTC John (Scott) Billie, Army Logistics University  
Assistant Chair: Chris Eastman, Lockheed Martin

Administrative Coordinators: Susan Reardon, Chief Executive Officer, MORS  
Jill Clark, Director of Events, MORS  
Eric Hamp, Director of Membership & Security, MORS  
Paul Laporte, Marketing Director, MORS  
Liz Marriott, Administrative Coordinator, MORS

Site Coordinators: Danielle Danforth, Lockheed Martin GVC  
Harry Lesser Jr, Lockheed Martin

MORS Bulldog: Dr. Tim Hope, WBB, Inc.

Workshop Kick-Off  
Coordinator: Annie Patenaude, FS, Consultant

Synthesis Chair: (Industry) Greg Keethler, Consultant  
(Government) Dr. Jerry Diaz, Analytic Insight, LLC, supporting the USAF  
Group: Joe Bobinis, Lockheed Martin (INCOSE Afford WG Chair)  
Fred Hartman, FS, IDA  
Ken "Crash" Konwin, Booz Allen Hamilton  
Annie Patenaude, FS, Consultant  
Frank Serna, Draper Labs (NDIA SE Affordability WG Chair)  
Cy Staniec, FS, Consultant  
Charlie Stirk, CostVision, Inc. (AMSWG & NDIA LCC Committee)  
Gene Visco, FS, Lockheed Martin

Working Group Chairs:

*1 – People, Authorities, Organizations, Methods and Tools*

Chair – (Industry) Bob Koury, Price Systems (INCOSE Afford WG)  
Chair – (Government) Ed Blankenship, HQMC P&R PA&E  
Assistant Chair – Dr. Anne Johnson, Raytheon Missile Systems  
Assistant Chair – Paul Ferguson, Lockheed Martin  
Assistant Chair – Matthew Anderson, Boeing  
Assistant Chair – Trena Lilly, JHU/APL

*WG 2 – Development Planning and the Early Life Cycle*

Chair – (Government) Col Steve Stoddard, PhD  
Chair – (Industry) Rick Null, Lockheed Martin  
Assistant Chair – Harry Conley, AF HQ, Air Force Material Command / A5C  
(MORSS Acquisition Workshop DP WG Co-Chair)  
Assistant Chair – Dr. Rebecca Mackoy, TRADOC Analysis Center  
Assistant Chair – Alix Minden, LCMI Engineering, PLLC

*WG 3 – Post-Milestone A and the Remaining Life Cycle*

Chair – (Industry) Dan Klingberg, Raytheon Missile Systems  
Chair – (Government) David Panhorst, US Army Armaments Research, Development, and  
Engineering Center  
Assistant Chair – Garry Roedler, Lockheed Martin  
Assistant Chair – Bruce Riggins, Boeing Research & Technology  
Assistant Chair – Angie Milano, The Johns Hopkins University Applied Physics Lab

*WG 4 – Affordability and Logistics / Sustainment Considerations*

Chair – (Industry) Bill Kroshl, JHU/APL  
Chair – (Government) Dan Nussbaum, Naval Postgraduate School (SCEA)  
Assistant Chair – Charlotte (Vicki) Evering, US Army Materiel Systems Analysis Activity  
Assistant Chair – Noreen Dahl, HQMC P&R PA&E  
Assistant Chair – David Frye, Lockheed Martin  
Assistant Chair – John McKendrew, JSF Program Office  
Assistant Chair – Greg Parlier, IDA (MAS President)

*WG 5 – Expanding the Affordability Definition and Trade Space: Providing a More Holistic Life Cycle Cost and Operational Outcomes View*

Chair – (Industry) Phil Fahringer, Lockheed Martin  
(MORS Acquisition Workshop Trade Space WG Co-Chair)  
Chair – (Government) Mike Knollmann, ASD(A) Joint Operations Support  
Assistant Chair – Paul Tuttle, Consultant (INCOSE Afford WG)  
Assistant Chair – Jeffrey Hamman, The Johns Hopkins University Applied Physics Lab  
Assistant Chair – Taki Turner, Boeing (INCOSE Afford WG Co-Chair)

**Sponsor/Service Reps:**

Air Force: Dr. Clay Bowen, Air Force Headquarters / A-9  
Army: Tom Rothwell, CAA  
Navy: Herb Cupo, OPNAV(N81)  
Marine Corps: Dr. Michael Bailey, MCCDC Studies & Analysis  
OSD: Mark Mulligan, OSD(CAPE)  
DHS: Dr. Arch Turner, S&T Directorate  
J8 LtCol Clay Stackhouse

## **12. Administrative**

Name – *Affordability Analysis: How Do We Do It?*

Dates – 1-4 October 2012

Location – Lockheed Martin Global Vision Center, 2121 Crystal Drive, Arlington, VA 22202

**Fees –**

Non-Government Non-MORS Member	\$750
Non-Government MORS Member	\$675
Government Non-MORS Member	\$650
Government MORS Member	\$575

Attendance – 200 people

Classification – Unclassified, open to foreign nationals





# Affordability Analysis: How Do We Do It?

1-4 October 2012 | Lockheed Martin Global Vision Center, Arlington, VA

## APPENDIX C – Planning Committee

### 1. Overall Workshop –

#### a. Workshop Chairs

- (1) Industry Co-Chair – Kirk Michealson, Lockheed Martin Corporation
- (2) Academia Co-Chair – Jack Keane, The Johns Hopkins University Applied Physics Laboratory
- (3) Government Co-Chair – LTC John (Scott) Billie, Army Logistics University

#### b. MORS Staff

- (1) Chief Executive Officer – Susan Reardon
- (2) Director of Events – Jill Clark
- (3) Director of Membership & Security – Eric Hamp
- (4) Marketing Director – Paul LaPorte
- (5) Administrative Coordinator – Liz Marriott

#### c. Site Coordinators

- (1) Danielle Danforth, Lockheed Martin Global Vision Center
- (2) Harry Lesser Jr, Lockheed Martin Corporation

#### d. MORS Bulldog

- (1) Tim Hope, Whitney, Bradley & Brown, Inc.

#### e. Workshop Kick-Off Coordinator

- (1) Annie Patenaude, FS Consultant

### 2. Synthesis Group –

- (1) Industry Co-Chair – Greg Keethler, Consultant
- (2) Government Co-Chair – Dr. Jerry Diaz, Air Force Material Command, Office of Aerospace Studies
- (3) Members –
  - Jim Bexfield, FS, Consultant
  - Joe Bobinis, Lockheed Martin Corporation (INCOSE Afford WG Chair)



- Fred Hartman, FS, Institute for Defense Analyses
- Ken “Crash” Konwin, Booz Allen Hamilton
- Annie Patenaude, FS, Consultant
- Frank Serna, Draper Laboratory (NDIA SE Affordability WG Chair)
- Cy Staniec, FS, Consultant
- Charlie Stirk, CostVision, Inc. (AMSWG & NDIA LCC Committee)
- Gene Visco, FS, Lockheed Martin Corporation

3. Working Groups –

a. Working Group 1, *People, Authorities, Organizations, Methods and Tools*

- (1) Industry Co-Chair – Bob Koury, Price Systems, LLC
- (2) Government Co-Chair – Ed Blankenship, Program Assessment and Evaluation Division, Programs and Resources Department, Headquarters Marine Corps
- (3) Assistant Chairs –
  - Dr. Anne Johnson, Raytheon Missile Systems
  - Paul Ferguson, Lockheed Martin Corporation
  - Matthew Anderson, Boeing
  - Trena Lilly, The Johns Hopkins University Applied Physics Laboratory

b. Working Group 2, *Development Planning and the Early Life Cycle*

- (1) Government Co-Chair – Col Steve Stoddard, PhD, Center for Army Analyses
- (2) Industry Co-Chair – Rick Null, Lockheed Martin Corporation
- (3) Assistant Chairs –
  - Harry Conley, AF HQ, Air Force Material Command / A5C (MORSS Acquisition Workshop DP WG Co-Chair)
  - Dr. Rebecca Mackoy, TRADOC Analysis Center
  - Alix Minden, LCMI Engineering, PLLC

c. Working Group 3, *Post-Milestone A and the Remaining Life Cycle*

- (1) Industry Co-Chair – Dan Klingberg, Raytheon Missile Systems
- (2) Government Co-Chair – David Panhorst, Army Research, Development & Engineering Center
- (3) Assistant Chairs –
  - Garry Roedler, Lockheed Martin Corporation
  - Bruce Riggins, Boeing Research & Technology
  - Angie Milano, The Johns Hopkins University Applied Physics Lab

d. Working Group 4, *Affordability and Logistics / Sustainment Considerations*

- (1) Industry Co-Chair – Bill Kroshl, The Johns Hopkins University Applied Physics Laboratory
- (2) Government Co-Chair – Dr. Dan Nussbaum, Naval Postgraduate School (SCEA Outreach Committee Chair)
- (3) Assistant Chairs –
  - Charlotte (Vicki) Evering, US Army Materiel Systems Analysis Activity



- Noreen Dahl, Program Assessment and Evaluation Division, Programs and Resources Department, Headquarters Marine Corps
- Dr. David Frye, Lockheed Martin Corporation
- John McKendrew, Joint Strike Fighter Program Office
- Dr. Greg Parlier, Institute for Defense Analyses (INFORMS MAS President)

e. Working Group 5, *Expanding the Affordability Definition and Trade Space*

- (1) Industry Co-Chair – Phil Fahringer, Lockheed Martin Corporation
- (2) Government Co-Chair – Mike Knollmann, Assistant Secretary of Defense for Acquisition, Joint Operations Support
- (3) Assistant Chairs –
  - Paul Tuttle, Consultant (INCOSE Afford WG)
  - Jeffrey Hamman, The Johns Hopkins University Applied Physics Lab
  - Taki Turner, Boeing (INCOSE Afford WG Co-Chair)



# Affordability Analysis: How Do We Do It?

1-4 October 2012 | Lockheed Martin Global Vision Center, Arlington, VA

## APPENDIX D – Read Aheads

Available via the MORS Affordability Analysis Workshop Read Ahead Page:

<http://www.mors.org/events2012aareadaheads.aspx>

### 1. Overall Workshop –

- a. Affordability Glossary
- b. MORS Special Meeting Reports

- (1) *MORS Risk, Trade Space and Analytics in Acquisition Workshop, Development Planning Working Group Outbrief, September 2011*
- (2) *MORS Emphasizing the Cost in Cost and Operational Effectiveness Analyses, (joint with Society of Cost Estimating and Analysis, SCEA), March 1993*
- (3) *MORS COEA in the Acquisition Process and the Role of Operations Research in Performing COEA, March 1992*

### c. Better Buying Power Memos

- (1) *Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending, 14 September 2010*
- (2) *For OIPT Leads: Implementation Directive for Better Buying Power – Restoring Affordability and Productivity in Defense Spending, 14 September 2010*
- (3) *For Director, Acquisition Resources & Analysis – Implementation Directive for Better Buying Power – Restoring Affordability and Productivity in Defense Spending, 14 September 2010*
- (4) *For Director, Defense Research & Engineering – Implementation Directive for Better Buying Power – Restoring Affordability and Productivity in Defense Spending, 14 September 2010*
- (5) *For Director, Defense Procurement & Acquisition Policy – Implementation Directive for Better Buying Power – Restoring Affordability and Productivity in Defense Spending, 14 September 2010*
- (6) *For Directors of Defense Agencies – Implementation Directive for Better Buying Power – Obtaining Greater Efficiency and Productivity in Defense Spending, 14 September 2010*
- (7) *Guidance Roadmap, 16 September 2011*

### d. OSD(ATL) Affordability Memos

- (1) *The Defense Industry Enters a New Era, 9 February 2011*
- (2) *Should-Cost and Affordability, 24 August 2011*



- (3) *Joint Memorandum on Savings Related to Should Cost*, 22 April 2011
- (4) *Product Support Research & Tools*, Defense Acquisition University Website, <https://acc.dau.mil/CommunityBrowser.aspx?id=497537>

e. NDIA SE Division Documents

- (1) *M&S Committee: Measuring of Life Cycle / Operations & Support Costs: To what degree is commonality achievable?*, 21 April 2011

f. INCOSE Affordability Working Group Documents

- (1) *Affordable Architectures – “How do I recognize one?”*, Tom Herald, Ph.D., Lockheed Martin Senior Fellow, February 2010
- (2) *INCOSE Design For Affordability Initiative*, Price Systems Blog, <http://blog.pricesystems.com/blog/quentins-quotes/incose-design-for-affordability-initiative>
- (3) *An Enterprise Framework for Operationally Effective System of Systems Design*, p 60, Journal of Enterprise Architecture, May 2012, Volume 8, Number 2, <http://www.mendling.com/publications/JEA12-2.pdf>
- (4) *INCOSE Affordability Working Group Web Page*
- (5) *Affordability*, Edwin Dean (INCOSE Affordability WG Member), Presented at the 2012 ISPA/SCEA Joint International Conference & Training Workshop, 14--16 May 2012, Brussels, Belgium
- (6) *Affordability Considerations: Cost Effective Capability*, INCOSE Affordability Working Group; Primary Authors: Joseph Bobinis, Jay Haimowitz, Paul Tuttle, Cheryl Garrison

g. Joint Staff Documents

- (1) *Joint Capabilities Integration and Development System (JCIDS)*, 19 Jan 2012
- (2) *JCIDS Manual Errata*, 11 June 2012
- (3) *Capabilities-Based Assessment User's Guide*, Version 3, March 2009

h. Risk Documents

- (1) *Risk Management Guide for DoD Acquisitions*, Sixth Edition, V 1.0, August 2006
- (2) *Toward a Risk Management Defense Strategy*, Nathan Freier, August 2009
- (3) *Risk Discussion for MORS Affordability Analysis Workshop*

i. Other General Affordability Information

- (1) *Targeting Affordability and Controlling Cost Growth through Should-Cost Analysis*, Anthony A DeMarco, President, PRICE Systems, L.L.C., 9 August 2011
- (2) *NATO Guidance on Life Cycle Costs*, ALCCP-1, Edition 1, July 2008



## 2. Working Group Read Aheads –

### a. Working Group 1, *People, Authorities, Organizations, Methods and Tools*

- (1) Working Group 1 Terms of Reference (TOR)
- (2) *Affordability Analysis for DARPA Programs*, William M. Kroshl and Peter P. Pandolfini
- (3) *Affordability* (Section 3.2), Defense Acquisition Guidebook, Defense Acquisition University Website
- (4) *Need for Affordability Analysis in Systems Engineering*, INCOSE Brief, Mark Schankman and Mike Franco, Boeing Research & Technology, 24 June 2009
- (5) *Affordability Assessments to Support Strategic Planning and Decisions at NASA*, Debra Emmons, Marcus Lobbia, Torrey Radcliffe & Robert Bitten, NASA Aerospace, 7 March 2010

### b. Working Group 2, *Development Planning and the Early Life Cycle*

- (1) Working Group 2 Terms of Reference (TOR)
- (2) *Defense Acquisitions: How DOD Acquires Weapon Systems and Recent Efforts to Reform the Process*, Moshe Schwartz, Congressional Research Service, 23 April 2010
- (3) *Early Development Planning Leads to Affordable Systems*, Chuck Kondrack& David Peterson, Advatech Pacific Inc., presented at 2010 NDIA SE Division Conference
- (4) *Findings and Recommendations from the Development Planning Working Group*, Presented at the February 2011 NDIA SE Division Meeting
- (5) *Directive-Type Memorandum (DTM) 09-027 – Implementation of the Weapon Systems Acquisition Reform Act of 2009*, OSD(ATL) Memo, December 04, 2009 (Incorporating Change 3, December 9, 2011)
- (6) *Industry's Role in Development Planning*, White Paper from NDIA SE Division-Sponsored Government & Industry Development Planning Workshop, 8-9 June 2010
- (7) *Implementation of Weapon Systems Acquisition Reform Act (WSARA) of 2009 (Public Law 111-23, May 22, 2009)*, Mona Lush, OSD(ATL), 22 October 2009
- (8) *Synopsis and Impact of Weapon Systems Acquisition Reform Act of 2009*, SM&A Brochure
- (9) *Development Planning*, OASD(SE) Website, [http://www.acq.osd.mil/se/initiatives/init\\_devplng.html](http://www.acq.osd.mil/se/initiatives/init_devplng.html)
- (10) *Government Development Planning Working Group Update*, June 2012

### c. Working Group 3, *Post-Milestone A and the Remaining Life Cycle*

- (1) Working Group 3 Terms of Reference (TOR)
- (2) *Making Affordability Work*, Dan Klingberg Raytheon Missile Systems and David Panhorst, Army Research, Development, & Engineering Center

### d. Working Group 4, *Affordability and Logistics / Sustainment Considerations*

- (1) Working Group 4 Terms of Reference (TOR)





e. Working Group 5, *Expanding the Affordability Definition and Trade Space*

- (1) Working Group 5 Terms of Reference (TOR)
- (2) *Cost vs. Risk in Defense Portfolios*, Sam Savage Stanford University and Phil Fahringer Lockheed Martin Corporation, March 2012 *MORS PHALANX*
- (3) *Affordability Specification*, Paul Tuttle Consultant and Joe Bobinis Lockheed Martin Senior Fellow Lockheed Martin Corporation



# Affordability Analysis: How Do We Do It?

1-4 October 2012 | Lockheed Martin Global Vision Center, Arlington, VA

## APPENDIX E – Presentations

Those approved for public release are available via the MORS Affordability Analysis Workshop Page: <http://www.mors.org/events/2012aa.aspx>.

### 1. Workshop Kick-Off –

- a. *Better Buying Power Memo Overview Impact on Affordability Analysis*, Dr. Mark Husband, Defense Acquisition University
- b. *Affordability Thinking: A Workshop for Getting the Big Picture*, Patricia Scaramuzzo, Dina Lacovara & Adam Ross, Lockheed Martin Corporation

### 2. Plenary Session –

#### a. Plenary Panel

- (1) *Affordability and Analysis of Alternatives*, Dr. Jerry Diaz, Air Force Material Command, Office of Aerospace Studies
- (2) *Affordability and NDIA SE Division*, Frank Serna, NDIA SE Division Co-Chair and Affordability Working Group Lead, Draper Laboratory
- (3) *Affordability and INCOSE*, Joe Bobinis, INCOSE Affordability Working Group Lead, Lockheed Martin Corporation

#### b. Lunchtime Presentation

- (1) *Affordability and the International Symposium on Military Operational Research (ISMOR)*, Gene Visco, FS, Lockheed Martin Corporation

### 3. Working Groups –

#### a. Working Group 1, *People, Authorities, Organizations, Methods and Tools*

- (1) *Affordability – What Works Best? (Rapid Affordability Tool or “RAT”)*, Edward R. Blankenship, Program Assessment and Evaluation Division, Programs and Resources Department, Headquarters Marine Corps
- (2) *Affordability – Whose Job Is it? (Different Approaches to Affordability)*, Edward R. Blankenship, Program Assessment and Evaluation Division, Programs and Resources Department, Headquarters Marine Corps
- (3) *An Affordability Process Framework*, Robert Koury, PRICE Systems, L.L.C.



b. Working Group 2, *Development Planning and the Early Life Cycle*

- (1) *Cost, Benefit and Capability*, Rick Null, Lockheed Martin Corporation
- (2) *Pre-Milestone A*, Rick Null, Lockheed Martin Corporation
- (3) *Thoughts on Affordability*, Gene Porter, Institute for Defense Analyses
- (4) *Analysis of Alternatives: Statute, Policy and Recent Practices*, Mark Mulligan, OSD(CAPE)

c. Working Group 3, *Post-Milestone A and the Remaining Life Cycle*

- (1) *Production & Deployment Post MS C Issues That Impact Cost/Value*, Dan Cernoch, Lockheed Martin Corporation
- (2) *Model Based Manufacturing Overview*, Dan Klingberg Raytheon Missile Systems
- (3) *Measures and Analysis for Affordability*, Peter McLoone, Lockheed Martin Corporation
- (4) *BY\$ Cost Projections Should Not Include Growth above Inflation Due to the Time Value of Money or: How I Learned to Stop Worrying and Love the OSD Inflation Indices*, Samuel A. Wright, Ph. D., HQ AFMC Studies and Analyses Division, HQ AFMC/A9A

d. Working Group 4, *Affordability and Logistics / Sustainment Considerations*

- (1) *The Use of Inflation Indices in the Department of Defense*, Dr. Stanley Horowitz, Institute for Defense Analysis
- (2) *Forecasting National Procurement Costs for the Joint Strike Fighter*, Dr. Paul Desmier, DRDC Center for Operational Research and Analysis (Canada)
- (3) *Fully Burdened Fuel Cost Model*, Don Bates, US Army Logistics Innovation Agency
- (4) *Strategic Cost Model*, Ben Solomon, DRDC Center for Operational Research and Analysis (Canada)
- (5) *Implementing Reliability into Support Cost Estimates*, Keith MacFarlane, Army Material Systems Analysis Activity
- (6) *Management Innovation for DOD Supply Chains*, Dr. Greg Parlier, MEI Technologies
- (7) *Optimizing the Portfolio of Affordability Investments*, Dr. David Frye, Lockheed Martin

e. Working Group 5, *Expanding the Affordability Definition and Trade Space*

- (1) *Analysis: Foundation for Sound Portfolio Management Practices*, Fred Gregory, Joint Staff / J8
- (2) *Enabling Robust Cost/Performance/Schedule Trade Space in the Joint Requirements Process*, Dr. Scott Maley, Joint Staff / J8



Affordability Analysis



Affordability Analysis



Affordability Analysis



Affordability Analysis



# Affordability Analysis: How Do We Do It?

1 -4 October 2012 | Lockheed Martin Corporation,  
Arlington, VA

Appendix G – Results Brief

**Kirk Michealson, Workshop Chair**

Cell Phone: 407-375-3440

[kirk.michealson@1979.usna.com](mailto:kirk.michealson@1979.usna.com)



## **Agenda**

- Background
- Description
- Definitions
- Recommendations
- Observations and suggestions
- Selected products
- Bottom Line





## Background

- **MORS Special Meeting on Risk, Trade Space and Analytics in Acquisition (September 2011)**
  - ❖ Discovered that affordability analysis was ill-defined.
  - ❖ Recommended
    - Developing and formalizing affordability analysis processes, including recognizing the difference between cost and affordability analyses
    - Affordability analysis should include mission-based, portfolio-based, and capability-based analyses.
- **NDIA & INCOSE Affordability Working Groups**
  - ❖ Have developed definitions for “affordability”
  - ❖ But now have approached MORS for defining “affordability analysis”
- **Purpose: Provide a forum for discussing approaches to *affordability analyses* , including methodologies, historical perspectives and recent innovations in order to discover new insights and approaches**





## Industry Marketing Partners

- **Advertise to their members and on their website**
- **Member participation on planning committee and during the workshop**



Promoting National Security Since 1919



- **Supporting Government Group**
  - ❖ Acquisition Modeling & Simulation Working Group
  - ❖ Link to the MORS Workshop on their website



## Participants

GOVERNMENT			INDUSTRY			ACADEMIA		
Organization	#	%	Organization	#	%	Organization	#	%
OSD	11	19.0%	Boeing	7	10.1%	ALU	2	16.7%
Joint Staff	4	6.9%	Lockheed Martin	31	44.9%	DAU	1	8.3%
Army	18	31.0%	Northrop Grumman	4	5.8%	JHU/APL	6	50.0%
Air Force	9	15.5%	Raytheon	5	7.2%	NPS	1	8.3%
Navy	2	3.4%	Other	18	26.1%	Stevens	1	8.3%
Marine Corps	7	12.1%	Consultant	4	5.8%	USC	1	8.3%
NASA	2	3.4%	<b>TOTAL -</b>	<b>69</b>	<b>44.8%</b>	<b>TOTAL -</b>	<b>12</b>	<b>7.8%</b>
Other	5	8.6%	FFRDC			FOREIGN NATIONALS		
<b>TOTAL -</b>	<b>58</b>	<b>37.7%</b>	Organization	#	%	Organization	#	%
<b>Workshop</b>			IDA	8	80.0%	Canada	3	60.0%
<b>TOTAL -</b>	<b>154</b>		MITRE	2	20.0%	Israel	1	20.0%
			<b>TOTAL -</b>	<b>10</b>	<b>6.5%</b>	UK	1	20.0%
						<b>TOTAL -</b>	<b>5</b>	<b>3.2%</b>

NOTE: Total Percentages are the organization percentages of the workshop total number (154), while organization percentages are percentages within the group (e.g., government, industry, academia, FFRDC & Foreign)



## **Some Key Questions**

- **What is affordability analysis?**
- **How is it different from cost-benefit / cost-effectiveness analyses?**
- **What is the state of the practice of affordability analyses?**
  - ❖ What is needed to conduct affordability analyses?
  - ❖ What is the preferred approach for incorporating the systems full life cycle in affordability analyses?
  - ❖ How should we measure the affordability of a force structure in a mission context?
- **What are some examples of how analytical rigor has been applied to support affordability analyses?**
- **What are the major future challenges?**



## Overview of Agenda

- **Monday afternoon: Kickoff with short briefs by the WG chairs on expectations followed by briefs on terminology, existing DoD guidance and on opportunities for the Workshop**
- **Tuesday morning**
  - ❖ **Keynotes**
    - Ms. Katrina McFarland, Assistant Secretary of Defense for Acquisition
    - Dr. Ray O Johnson, Senior Vice President and Chief Technology Officer, Lockheed Martin Corporation
  - ❖ **Plenary Panel**
    - OSD(ATL) Affordability Lead: Dr. Phil Anton, OSD(ATL)
    - CAIG Representative: Mr. Steve Miller, OSD(CAPE)
    - AoA Representative: Dr. Jerry Diaz, AF/A5RP, USAF AoA SME
    - J8 (JCIDs / CBAs): Brig Gen Scott Stapp, USAF, J8 Director of Requirements
    - NDIA SE Affordability WG: Frank Serna, Draper Labs, NCID SE Co-Chair
    - INCOSE Affordability WG: Joe Bobinis, Lockheed Martin Senior Fellow
- **Insights from ISMOR**, Gene Visco, MORS FS, Representative to ISMOR



## **Working Groups**

- **WG 1: People, Authorities, Organizations, Methods and Tools**
- **WG 2: Development Planning and the Early Life Cycle**
- **WG 3: Post-Milestone A and the Remaining Life Cycle**
- **WG 4: Affordability and Logistics / Sustainment Considerations**
- **WG 5: Expanding the Affordability Definition and Trade Space: Providing a More Holistic Life Cycle Cost and Operational Outcomes View**
- **Synthesis Group**
  - ❖ Synthesis and Integration



## Workshop Leadership

### MORS Affordability Analysis Workshop, Synthesis & Working Group Chairs

GROUP	CO-CHAIR	NAME	ORGANIZATION
Overall Workshop	Industry	Kirk Michealson	Lockheed Martin
	Academia	Jack Keane, FS	JHU/APL
	Government	LTC John (Scott) Billie	Army Logistics University
Synthesis Group	Industry	Greg Keethler	Consultant
	Government	Jerry Diaz	USAF
WG 1 People, Tools	Industry	Bob Koury	Price Systems
	Government	Ed Blankenship	HQMC P&R PA&E
WG 2 DP	Industry	Rick Null	Lockheed Martin
	Government	COL Steve Stoddard	Center for Army Analyses
WG 3 Post MS A	Industry	Dan Klingberg	Raytheon
	Government	David Panhorst	Army ARDEC
WG 4 Sustainment	Industry	Bill Kroshl	JHU/APL
	Government	Dan Nussbaum	NPS
WG 5 Trade Space	Industry	Phil Fahringer	Lockheed Martin
	Government	Mike Knollmann	ASD(A) JOS





# Affordability

## ▪ Dimensions

- ❖ Size dimension
  - DoD, Service, Mission Area, System
- ❖ Measurement dimension
  - Dollars, Lives, Time
- ❖ Phase dimension
  - Requirement, Acquisition, Operational

## ▪ Two “interpretations” of affordability

- ❖ “little a” – being frugal, cost efficient in executing programs
- ❖ “Big A” – for the cost, does the capability provide value in the context of other things needed

**Affordability is not an inherent “attribute” of a program, but rather an informed judgment when compared to something else**



## **Definition: Affordability Analysis**

- **Background**
  - ❖ Affordability analysis is strategic in nature
  - ❖ It looks at trade demands, dollars per capability, return on investment; and requires a behavioral change in culture
- **Definition**
  - ❖ The analysis of a portfolio to identify best mix of capabilities to achieve mission at least cost; an assessment of value and cost
  - ❖ The analysis of a system to minimize the cost of achieving the desired capability over the full life cycle
- **As a comparison**
  - ❖ Cost analysis is a dollar breakdown of the implementation phase, tactical in nature with extensive use of estimation tools
  - ❖ Cost analysis, cost benefit analysis and capabilities based assessment contribute to affordability analyses



## State of the Practice

- **Weak although there are pockets of successful affordability efforts**
  - ❖ OSD (CAPE) Defense Planning Projection – 25-year time horizon
  - ❖ Joint Light Tactical Vehicle (JLTV) Program for Army and Marine Corps – real trades (post-AoA) to make the vehicle viable
  - ❖ 3-Dimensional Expeditionary Long-Range Radar (3DELRR) Program for the Air Force – good collaboration between the Service and industry
  - ❖ JSF Cost Forecasting Methodology from Canada – peer review process to forecast sustainment costs
  - ❖ Fully Burdened Cost of Fuel methodology from the Army – compares affordability savings to warfighting capability gains
- **Process, people and tools stoplight evaluation:**
  - ❖ Processes: **RED** (broken or nonexistent and not formalized, lack analytical rigor)
  - ❖ People: **YELLOW** (some shrinkage of the analytic base occurring and the need for the combination of analytic capability and acquisition knowledge and experience)
  - ❖ Tools: **GREEN** (sufficient tools available – optimization techniques, etc).



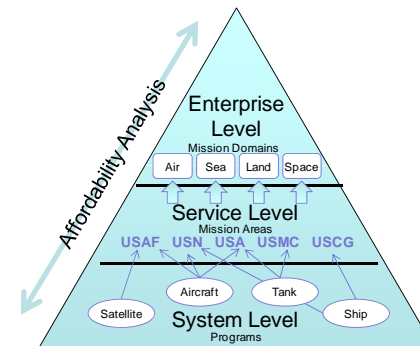
## **Major Recommendations**

- **Define affordability analysis concepts, including portfolios**
- **Develop an affordability analysis “how to manual”**
  - ❖ People, authorities, skills, processes, methods, data and standards
  - ❖ Drivers, strategies, information needs, metrics and analyses across the life cycle
  - ❖ Relationship between resources and readiness
  - ❖ Best practices from other organizations (i.e., FEDEX, UPS, Amazon, etc.)
  - ❖ Potentially use one to two pilot projects
- **Identify organizational accountability across the full life cycle**
- **Develop a trace-back capability for key decisions**



## Affordability Portfolios

- **Affordability analysis occurs at portfolio and system levels**
  - ❖ The portfolio levels (Enterprise / DoD and Service) enables trades across sets of systems based on their capability contribution to achieving mission success.
  - ❖ Affordability is inseparable from prioritization.
- **Tools are available to “optimize” portfolios – defining the portfolio and measures, and obtaining good data may prove to be major challenges**
- **RECOMMENDATION: define portfolios; review earlier similar activities to gain insights**
  - ❖ Capability Based Planning
  - ❖ Joint Capability Areas
  - ❖ Defense Planning Projections (OSD/CAPE)





## Affordability Processes

- **Completeness: to date affordability analysis mostly occurs pre-Milestone A**
  - ❖ Costs beyond the FYDP are rarely considered (too hard to estimate)
  - ❖ Result is often a “bow wave” in the long term that, if considered early, may have resulted in the system being “unaffordable”
- **Accountability: no one organization is responsible for all elements of the life cycle cost**
  - ❖ Account for all O&S costs: Logisticians need a seat at the Milestone Decision Authority (MDA) decision table to raise the level of attention for sustainment\*
  - ❖ Maintain and update an accountability trace for key decisions over time
  - ❖ Consider contract language to push accountability to the prime contractors
- **Sensitivity analyses: avoid point estimates**
  - ❖ Affordability analysis must use the full range of cost estimates
  - ❖ Both the high and the low estimate should be part of the analysis
- **RECOMMENDATION: Modify the acquisition framework to include an affordability "how to do it" manual based on a couple of pilots describing the tenets of affordability analysis, some examples, tools, and process suggestions including qualitative assessments, risk, uncertainty, and accountability**





## **Affordability Linkages**

- **Need: develop a means to track changes in assumptions, KPP's, threats and other bases for requirements throughout the program**
  - ❖ Items get incrementally changed as the program moves along and there is no record nor traceability of it
  - ❖ There is a linkage of key data and information needed across the life-cycle
- **Accountability: maintain a trace for key decisions**
- **RECOMMENDATION: develop a trace back capability; perhaps through Joint Capability Areas (JCAs) and Uniform Joint Task Lists (UJTLs)**
  - ❖ Could be part of a new affordability process



## **The Affordability Analyst**

- **The Operations Analyst**

- ❖ Needs clear guidance to include delivery of products that include a portfolio view, the total ownership costs over the long-term (post-FYDP years), and trade space between cost, quantity, performance, schedule, and risk.

- **Should maintain good communications with decision makers.**

- **Have a good basic operations analysis skill-set with an understanding of**

- ❖ Acquisition process
- ❖ Decision analysis and Optimization techniques for making comparative choices
- ❖ Cost estimating techniques
- ❖ And attend the Requirement Manager's Training Course



## Additional Suggestions

- **Establish sustainment cost targets**
  - ❖ With clear responsibilities
  - ❖ Can be up to 75% of LCC (fuel, spare parts, ...)
  - ❖ Use operations and support Concept of Operations (CONOPS) developed in AoA
  - ❖ Use methods for estimating the sustainment cost at different points in the life cycle
  - ❖ Keep target unless the operating concept changes, or program re-baselined.
  - ❖ O&S cost estimates confidence intervals may be adjusted for as program matures
- **Explore use of Cost as an Independent Variable (CAIV)**
  - ❖ CAIV curve identifies diminishing returns, the point at which more investment results in small increases in capability.
  - ❖ Capability achieved for the cost invested may be a qualitative estimate by subject matter experience or may be derived from detailed modeling
- **Permit flexibility in performance requirements in pursuit of affordability**
  - ❖ Minimum performance parameters may be either beyond the laws of physics or unattainable from a fiscal perspective.
  - ❖ Using a performance range may radically reduce the development and procurements costs of a system – while still meeting mission needs.

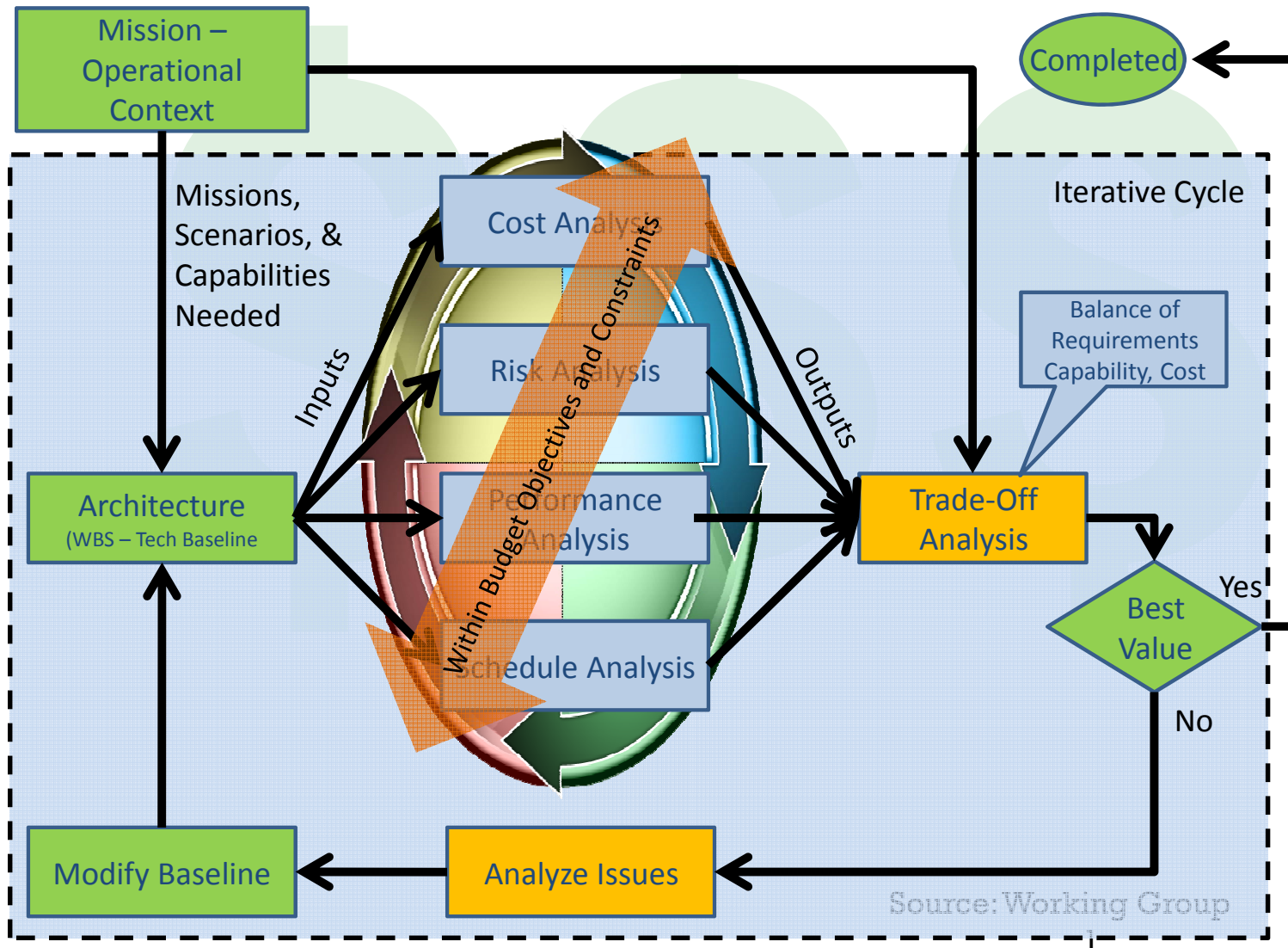


## **Affordability Special Products**

- **Some “special products” were started during the workshop**
  - ❖ “Generic” Affordability Process
  - ❖ Affordability Analysis People, Process, Tools Matrix
  - ❖ Affordability Analysis Information Needs Matrix
- **All need work, but could be used as inputs when working the major recommendations**
  - ❖ Affordability Processes
  - ❖ Affordability Accountability
  - ❖ Affordability Linkages



## Special Product: Generic Affordability Process





## Special Product: Affordability Analysis Matrix

Level	Description	Who	Authorities	Skills	Process	Methods	Tools	Measures	Data	Standards
Prioritization of Requirements / Portfolio	Prioritization of KPP's/Requirements and Allocation of Capabilities to Strategy/ies (and/or associated KPP's/Requirements): 1. Allocation of operational capability.	J-8	Joint Staff	Financial Managers	Requirements prioritization Analysis of Alternatives;	TRL Levels	MARCUS (Can); Time Series	Contribution to Mission Success AoA with requirement relief (trade off of mission capabilities)  Multi-variant trade offs (perf/cost metrics)		
		JROC (Portfolio)	JROC	ORSA		Sensitivity Analysis Uncertainty Quantification in Risk Analysis	Decision Support Dashboard			
		Joint Staff	Service Chiefs	Systems Engineers		Data Mining (historical data) to develop predictive models M&S	Design of Experiments (DOE)			
		BSO	Components: Budget Submitting Offices Resource Sponsors			Design of Experiments	Reliability Software			
		DoD Component Capability Organizations (E.g., USMC MCCDC)					Data Mining Software			
		Resource Sponsors Portfolio/Enterprise				Better Baseline Analysis	Data Viz Software  GAMS (Optimization Tool) Combat Simulations Value Added Analysis			

- **Source: Working Group 1**

- ❖ A table was started to describe the affordability analysis by who, authorities, skills needed, process, methods, tools, measures, data and standards
- ❖ For each level of oversight: National, Enterprise, Portfolio and System





## **Special Product: Affordability Analysis Information Needs Matrix – Example: Engineering & Manufacturing Development Phase**

### **Drivers (Key Decisions)**

- Considerations during EMD that can impact affordability
- Interim impacts through the development

### **Strategies (Key Considerations)**

- Adaptability/flexibility to enable emerging requirements/behaviors
- Modular Open Systems Architecture (MOSA) can help manage
- Common platforms that can evolve over time; evolutionary approaches
- Cost reduction opportunities
- Management of Key Critical Parameters – match mfg process capability
- Culture change focused on affordability
- Have more than one party compete during EMD phase for high risk programs

### **Information Needs**

- Terms needed to make affordability work
- Cost requirements
- Interfaces and interactions between the system and enabling systems
- Materials and manufacturability
- Security/Cyber-Security

### **Metrics**

- Sustainment maturity/effectiveness
- Manufacturing Readiness

### **Analysis**

- Modeling and simulation to better analyze trades
- Is the system/element suitable?
- Cost modeling disconnects
- Need to have a robust cost-modeling capability developed
- Continued use of cost modeling and analysis needed throughout the phase and life cycle
- Shared cost modeling to enable better communication, expectations and affordability decisions
- MOSA can also reduce risk
- Materials and manufacturability trades
- Operations and sustainment costs and trades
- Supply chain delivery timing
- Test coverage
- **Source: Working Group 3**
  - ❖ A table was started for each phase of the life cycle to describe the affordability analysis information needs by drivers, strategies, information needs, metrics and analysis



## **Workshop Bottom Line**

- **Define affordability analysis contexts, including portfolios**
- **Develop an affordability analysis “how to manual”**
- **Specify organizational accountability across the full life cycle**
- **Establish sustainment cost targets**
- **Maintain and update an accountability trace for key decisions over time**
- **Tools and methodologies appear to be adequate – need standard processes and quality data**
- **Explore use of Cost as an Independent Variable (CAIV)**
- **Create dynamic and interactive visualizations to provide a better understanding of the affordability trade space**



## **Results Brief: Comments & Recommendations**

### **▪ Workshop Proponent, Assistant Secretary of Defense (Acquisition)**

- ❖ Craft more dynamic portfolio definitions depending on the mission context understanding the decision that needs to be made.
- ❖ Already mandated to look out 30 years and have a Logistician at the MDA table.
- ❖ J8 has already adapted CAIV curves for affordability.
- ❖ Reviewing the 1989 “Design to Cost” book by Jack Michaels.

### **▪ Deputy J8**

- ❖ Ensure the qualitative aspect of affordability is included in the new process.
- ❖ Ensure the new affordability analysis process not be focused on cost, but on the mission or value.
- ❖ Test the new process on a couple of pilot programs.
- ❖ Ensure the operations analyst has an understanding of the requirements process.

### **▪ Other Briefs**

- ❖ Cost should be a KPP
- ❖ Include the sustainment quad chart in the affordability analysis process.
- ❖ Create a dynamic visualization to allow “what if” drills.
- ❖ Mostly, this is more cost-effectiveness rather than affordability.



## **Next Steps**

- **STEP 1: Establish the Team**
- **STEP 2: Review Current Information**
- **STEP 3: Complete the Workshop Major Recommendations**
- **STEP 4: Test the Process**



# Back-Ups



## **BACKGROUND: MORS Overview**

- **Military Operations Research Society (MORS)**

- ❖ MORS is a professional society of multi-disciplined Operations Research Analysts to enhance the quality of unclassified and classified analysis related to national security.

- **MORS Sponsors**

- ❖ Assessment Division (N81), Chief of Naval Operations
- ❖ Center for Army Analysis (HQDA/Programs, G-8)
- ❖ Studies and Analyses, Assessments and Lessons Learned (HQ USAF/A9)
- ❖ Marine Corps Combat Development Command
- ❖ Cost Analysis and Program Evaluation (CAPE), Office of the Secretary of Defense
- ❖ Science & Technology Directorate, Department of Homeland Security

- **Other Supporters**

- ❖ Joint Staff – J8

- **Workshop Proponent**

- ❖ Assistant Secretary of Defense for Acquisition





## **OVERVIEW: Workshop Purpose**

- **Provide a forum for discussing Defense Department (i.e., Army, Navy, Marine Corps, Air Force, and Joint) approaches to *affordability analyses throughout the life cycle.***
- **Provide an opportunity for operators, engineers, decision makers, academicians, and military and civilian operations research analysts**
  - ❖ To examine topics, methodologies, analyses, and innovations pertinent to all aspects of analysis for affordability as a function of total ownership cost and system performance
- **Balance “voyage of discovery” without “distracting from the work already completed” – moving forward**



## OVERVIEW: Workshop Kick-Off

- **Monday afternoon before workshop**
- **Set expectations and provide a foundation, guidance & opportunity**

### MORS Affordability Analysis Workshop Kick-Off

TIME	SESSION	TOPIC	PRESENTER
1330	Overview	Welcome	Kirk Michealson, Workshop Chair
1335	Workshop Expectations	Workshop & WG Chairs	Kirk Michealson, Workshop Chair
			WG 1 - Bob Koury, Price Systems
			WG 2 - COL Steve Stoddard, CAA
			WG 3 - Dan Klingberg, Raytheon
			WG 4 - Bill Kroshl, JHU/APL
			WG 5 - Phil Fahringer, Lockheed Martin
1405	The FOUNDATION	Terminology Overview	Glossary Team Lead - Frank Serna, Draper
<b>1445</b>	<b>BREAK</b>		
1500	The GUIDANCE	"Better Buying Power" Memos	Dr. Mark Husband, DAU
1545	The OPPORTUNITY	Affordability Thinking	Patti Scaramuzzo, Lockheed Martin
1645	Wrap-Up		Kirk Michealson, Workshop Chair
<b>1700</b>	<b>END OF WORKSHOP KICK-OFF</b>		



## **RESULTS: Affordability Accountability**

- **No one person is responsible life cycle cost across the acquisition stovepipes.**
  - ❖ Results are that decisions are made without full accounting of true and complete costs.
  - ❖ Full O&S costs are typically not accounted for in the development or requirements phases, creating that unseen “bow wave.”
  - ❖ Postures subsequent phases for failure and problem resolution is more expensive the later it occurs.
  - ❖ The Bottom Line: It results in apparent “affordability” in FYDP, i.e., may be able to buy, but then do not have funds to maintain or drive.
- **Roles and responsibility / accountability must be defined. Program decisions need to consider:**
  - ❖ Full life-cycle costs,
  - ❖ An accountability trace for key decisions must be maintained, and
  - ❖ Identification and elimination of the “bow wave” is essential.
  - ❖ Who ensures these occur?



## **WORKING GROUP 1 Objectives**

- **WG 1 People, Authorities, Organization, Methods & Tools Objectives**
  - ❖ Identify the state of the art in affordability analysis
  - ❖ Highlight team composition (with roles & responsibilities)
  - ❖ Recommend tools, and methods that contribute to good affordability analysis
  - ❖ Identify skills sets needed
  - ❖ Determine if techniques are quantitative, qualitative or both
  - ❖ Recommend affordability “measures”



## WORKING GROUP 1 Participants (20)

<b>Name</b>	<b>Organization</b>	<b>EMAIL</b>	<b>Citizenship</b>
Paul Ferguson	Lockheed Martin	<a href="mailto:paul.h.ferguson@lmco.com">paul.h.ferguson@lmco.com</a>	US
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## **WG FINDINGS: WG 1 – People, Methods, Tools**

- **Created an Affordability Analysis Taxonomy and Level Pyramid**
- **Suggested a “Generic” Affordability Process**
- **Started an Affordability Analysis Matrix for the different levels with**
  - ❖ People
  - ❖ Authorities
  - ❖ Skills
  - ❖ Processes
  - ❖ Methods
  - ❖ Measures
  - ❖ Data
  - ❖ Standards
  - ❖ NOTE: The matrix needs to be completed & reviewed in follow-up work



## **WORKING GROUP 2 Objectives**

- **WG 2 Development Planning & Early Life Cycle Objectives**
  - ❖ Determine prior to Milestone A, what is required for a first-cut affordability analysis (i.e., Pre-MDD and Post MDD to Pre-Milestone A)
  - ❖ Identify how affordability analysis supports the Development Planning process
  - ❖ Identify which components of life cycle costs tend to generate unaffordability pre-Milestone A
  - ❖ Determine decisions that are key to affordability
  - ❖ How do we adequately consider Total Ownership Cost prior to Milestone A





## **WORKING GROUP 2 Participants (25)**

- Frank Decker TRADOC Analysis Center (TRAC)
  - Bob Epps Lockheed Martin
  - Brian Gladstone, IDA
  - Roger Haiar Lockheed Martin Aeronautics
  - George Harris, AMSO, Center for Army Analysis
  - Donna Jones Defense Intelligence Agency
  - John Keough The Boeing Company
  - Jeff Loren DRC HPTG
  - Michael Mignone DIA
  - Mark Mulligan, OSD(CAPE)
  - Annie Patenaude, Synthesis Group
  - Dennis Pippy SAF/AQ - AFHSIO
  - Gene Porter IDA
  - Mike Remias Lockheed Martin
  - Jim Rodrigue Raytheon
  - JD Shumpert, Northrop Grumman
  - Mario Solano, HQMC, I&L Logistics Ops
  - Aileen Sedmak, OASD(SE)
  - Dana Trzeciak, PAIO
  - Mike Winzeler, Lockheed Martin
- Working Group Leadership
- Col Steve Stoddard (CAA)
  - Rick Null (Lockheed Martin)
  - Harry Conley (AFMC/A5C)
  - Dr. Becky Mackoy (TRADOC Analysis Center)
  - Alix Minden (LMCI Engineering)



## **WG FINDINGS: WG 2 – Development Planning**

- **Drivers of “un-affordable” solutions**
  - ❖ Mistakes and poor decisions
  - ❖ Focus concentrated on acquisition costs and FYDP concerns while minimizing or ignoring O&S costs
  - ❖ Lack of sound architecture practices limit capability trade space understanding
- **Additional recommendations**
  - ❖ A distribution or range of costs should be used when estimating, single point estimates could flaw the overall analyses
  - ❖ Document the ground rules and assumptions for the estimates
  - ❖ Include a comprehensive range of “what if” or sensitivity analyses
  - ❖ Identify drivers of uncertainty and apply lessons learned and past program performance history to isolate, control and reduce uncertainty
  - ❖ Introduce analytic methods such as stochastics, Monte Carlo randomness and probability theory to address uncertainty concerns
  - ❖ Address risk by analyzing severity or risks and probability of occurrence



## **WORKING GROUP 3 Objectives**

- **WG 3 Post-Milestone A & the Remaining Life Cycle Objectives**
  - ❖ After Milestone A, determine the scope of affordability and what factors are most important
  - ❖ Identify what information is available to conduct affordability analyses and should-cost incentives
  - ❖ Identify how Total Ownership Cost and affordability analysis are adequately considered with both the system of interest, other systems that integrate, and the enabling systems
  - ❖ With missions evolving over time, recommend how we account for that and still keep the design affordable



## **WORKING GROUP 3 Participants (20)**

- James Callow
  - Lorri Crittenden
  - Steven Glenn
  - Daniel Klingberg
  - Peter McLoone
  - Anjali Milano
  - Thomas Mulczynski
  - Steve Orth
  - David Panhorst
  - Bruce Riggins
  - Garry Roedler
  - Jared Sullivan
  - Dan Cernoch
  - Gary Downs
  - Charlie Stirk
  - Jim Bexfield
  - Everet Johnson
  - Crash Konwin
  - Marlena McWilliams
  - Sam Wright
- Boeing
  - Lockheed Martin
  - Raytheon
  - Raytheon
  - Lockheed Martin
  - JHU/APL
  - Naval Center for Cost Analysis
  - Raytheon
  - US Army Armaments
  - Boeing
  - Lockheed Martin
  - Northrop Grumman
  - Lockheed Martin
  - Lockheed Martin
  - CostVision
  - self
  - TRADOC Analysis Center
  - Booz Allen
  - PRICE Systems
  - AFMC/A9A



## **WG FINDINGS: WG 3 – Post-Milestone A**

- **Started an Affordability Analysis Information Needs Matrix for each of the life cycle phases with**
  - ❖ Drivers
  - ❖ Strategies
  - ❖ Information Needs
  - ❖ Metrics
  - ❖ Analyses
  - ❖ NOTE: The matrix needs to be completed & reviewed in follow-up work
- **Additional recommendations**
  - ❖ Model based visualization should be incorporated in contractor statements of work to improve development cycle time and affordability of development programs. It provides early insight into testability, manufacturability and sustainability.
  - ❖ Operations and support Concept of Operations (CONOPS) were developed as part of AoA and should be transitioned to the contractor once an award is made to provide continuity and an evolution path for future phases of O&S analysis.



## **Special Product: Affordability Analysis Information Needs Matrix – Example: Technology Demonstration Phase**

### **Drivers (Key Decisions)**

- System development and integration
- Problems during operations lack of interface definition
- No room left in interfaces to adjust adaptability
- Enabling systems – a system that needs another system to operating i.e. existing system or do I need new technology

### **Strategies (Key Considerations)**

- 3 dimensional visualization/modeling started at concept and materializes over the development process
- Time of need to time of fielding - reassess need and capability at each milestone
- Designer, manufacturers and maintainers working together
- Incremental capability/design allows learning gains
- Real time collaboration
- concurrent concept and design
- Paradigm shift – trade incremental in development and operations and support
- Manufacturing and maintenance strategies
- Simultaneous use of Tools/models (vetted by government)/common models
- Living models going through the system development
- Continuous/cross mixing manufacturing lines

### **Information Needs**

- Pre-milestone A – capability is being defined, design has not been locked in
- Trade space has been reduced
- Requirements creep – desirements vs requirements

### **Metrics**

- Less mature vs. mature technology
- Level of requirements detail
- Requirements changes need to have associated cost and schedule impacts
- How early do I have a return on investment cost curve?
- Interface maturity
- Dollars/capability
- Lacking sustainment readiness level

### **Analysis**

- How to you get the most bang for your buck?
- What are the cost drivers in the life cycle
- How can you bring these costs down?
- Capability versus cost

### **Source: Working Group 3**

- ❖ A table was started for each phase of the life cycle to describe the affordability analysis information needs by drivers, strategies, information needs, metrics and analysis



## **Special Product: Affordability Analysis Information Needs Matrix – Example: Production & Deployment Post-Milestone C Phase**

### **Drivers (Key Decisions)**

- Maintenance of factories
- Make/buy
- Test strategy (tiering)
- Assembly sequence
- Innovation workshops (material & ideas)
- Funding profile
- New shiny tool rather than reuse
- Plant efficiency
- Proposal efficiency
- Supply chain
- SEPM
- Quantities/uncertainty

### **Strategies (Key Considerations)**

- Multiyear buys
- Across program buy
- Bundle (15% estimated savings)
- Work funding across multi-year
- Risk/opportunity (How do you achieve efficient production state?)
- Commercial solutions (upgrade, open architecture, economies of scale (good and bad) & counterfeit)
- Failure review boards
- On-site reps
- Intern programs
- Core competency evaluation

### **Information Needs**

- Supplier integrity (counterfeit parts, sample screening, quality expectation & timely delivery/yield)
- Loss of brain trust

### **Metrics**

- Knowledge continuity/transfer/obsolescence
- Process capability
- Age profile
- Continuity management
- TACIT knowledge

### **Analysis**

- Multi-year buy
- Co-production
- Age distribution/trending
- Where do they work in life cycle
- What's the impact on risk?
- Lean (assembly process)
- Long-term ROI (why is it relevant?)
- Investment in tools
- Long term incentives impact
- Identification of key parameters that need to be carried forward
- Assumptions/decision rationale
- Analyzing impact on long-haul (materials, tooling & technology)

### **Source: Working Group 3**

- ❖ A table was started for each phase of the life cycle to describe the affordability analysis information needs by drivers, strategies, information needs, metrics and analysis





## **Special Product: Affordability Analysis Information Needs Matrix – Example: Operations & Support Phase**

### **Drivers (Key Decisions)**

- Inherent capability of system (reliability, maintainability, support)
- Operations - when system up/available what is the actual environment, how will it be used
- Support - how hard is it to repair, responsiveness, carrying cost
- Production line capability
- Understanding reliability based on deployed/usage - capability volume over time
- Planned vs. actual CONOPS (evaluation)
- Surge capability
- OPTEMPO layers

### **Strategies (Key Considerations)**

- End-in-view sustainment strategy
- CONOPS feedback loop for reset
- Models and analysis of evolving CONOPS
- What are the continued model to revisit affordable capability as part of BCA
- Performance based contractors

### **Information Needs**

- Impact across the entire system of systems
- CONOPS more fully articulated up front - what is the knee in the curve
- How does surge capability drive production/support - how much margin required
- Expected demand limits (upper/lower)
- Strategic CONOPS vs mission operation specific
- O&S pareto

### **Metrics**

- Reliability
- Availability
- Cost
- Mean downtime
- O&S cost (CAPE)

### **Analysis**

- O&S cost pareto
- WG#4 drill down further - accountability and governance
- CAPE metric
- Business case analysis (alternatives, affordability, what's changed)

### **Source: Working Group 3**

- ❖ A table was started for each phase of the life cycle to describe the affordability analysis information needs by drivers, strategies, information needs, metrics and analysis



## **Special Product: Affordability Analysis Information Needs Matrix – Example: Cross-Cutting, Cross-Phase and Other Considerations**

### **Drivers (Key Decisions)**

- Uncertainty in maintenance
- Validity of Assumption - reliability, availability, maintainability
- Workforce availability/skill level
- Is the analogy a valid one
- Knowledge/experience of estimators across phases
- Social/political (BRAC, depot closures, health care)
- Regulations (ejection chair, green ammo, insensitive explosives)
- Audit business practices

### **Strategies (Key Considerations)**

- Range estimates rather than point solutions - TOC is probably not right
- Probabilistic approach to estimate
- Stand up a capability to develop an analytic unit for early logistics cost evaluation -strong leadership
- Cost analysis to support wedge of money for capability we want
- Utilization of rapid acquisition
- Utilize foreign supplier base

### **Information Needed**

- Right way to account for inflation
- What's the purpose of the data? (future budget, calculate real growth)
- Do we have a target number? Even if we do is it right?

### **Analysis**

- What's the right inflation index?
- How do we develop an accurate Life Cycle Sustainment Plan
- Analogy estimates after MSB?
- McCurdy-Nunn
- Tiering R&D cost based on O&S cost

### **Assumptions**

- Trends of the past are the trends of the future?

### **• Source: Working Group 3**

- ❖ A table was started for each phase of the life cycle to describe the affordability analysis information needs by drivers, strategies, information needs, metrics and analysis



## **WORKING GROUP 4 Objectives**

- **WG 4 Affordability and Logistics / Sustainment Objectives**
  - ❖ Identify what needs to be considered to address logistics & sustainment, as well as manufacturing and supply chain, costs across the life cycle related to affordability analysis
  - ❖ Determine how uncertainty and the differences in sustainment strategies affect affordability
  - ❖ Identify any strategies that are particularly beneficial from an affordability perspective
  - ❖ What are the logistics and sustainment-related cost models? Are they useable for affordability analyses across the life cycle? If so, how? If not, why not?
  - ❖ What are the existing Cost Metadata Standards/Specifications that will support credible and consistent Operations and Sustainment Cost estimations? Is there a need for them? How does this help affordability analyses?
  - ❖ What is the cost of sustaining an affordable force structure?
  - ❖ What about the affordability of non-life cycle sustainment capabilities?



## WORKING GROUP 4 Participants (28)

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Richard Cline	The Boeing Company	Samuel Nantze	TRADOC Analysis Center
Walt Cooper	Technomics	Daniel Nussbaum	Naval Postgraduate School
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Dale Johnson	Lockheed Martin Corporate	Tolga Yalkin	Canadian Parliamentary Budget Office



## **WG FINDINGS: WG 4 – Logistics / Sustainment**

- **Several recommendations were made;**
  - ❖ Logisticians need a seat at the Milestone Decision Authority (MDA) decision table to raise the level of attention for sustainment
  - ❖ Standard process and methodology would help with sustainment affordability
  - ❖ Incentivizing optimizing across the Enterprise is needed
  - ❖ Leveraging supply chain innovation to manage sustainment costs
  - ❖ Learning best practices at UPS, FEDEX, Amazon
  - ❖ Accountability for lifecycle costs
  - ❖ Deriving better affordability metrics
  - ❖ Relating resources to readiness for current systems



## **WORKING GROUP 5 Objectives**

- **WG 5 Expanding the Affordability Trade Space: More Holistic Life Cycle Cost & Operational Outcomes View Objectives**
  - ❖ Identify best methods and practices to examine the trade space associated with affordability with respect to readiness and capability
  - ❖ Determine the impact of the capability on the operational outcome and at what total cost
  - ❖ Determine how an affordable solution includes understanding of what risks are being accepted in terms of meeting performance outcomes
  - ❖ Can we afford the ability to perform the mission? Can we afford the mission?



## WORKING GROUP 5 Participants # 1 (38 total)

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Ms.	Philomena	Zimmerman		ODASD(SE)



## **WG FINDINGS: WG 5 – Trade Space**

- **Reinforced the need for dynamic and interactive visualization applications to be developed and presented to leadership vice PowerPoint slides.**
  - ❖ These visualizations must enable leadership to interact within the entire trade space so individually they can identify what they feel is “the most affordable solution”.
  - ❖ The goal would be to display multiple outcomes and parameters simultaneously being interactive for decision makers



## **Synthesis Group Participants (11)**

- Greg Keethler (Industry Co-Chair, Inquisit, LLC)
- Dr. Jerry Diaz (Government Co-Chair, AF/AFMC/OAS)
- Jim Bexfield (At-large Synthesis Group member, MORS Fellow)
- Charlie Stirk (Roaming Synthesis Group member, AMSWG Rep)
- Gene Visco (WG 1 Synthesis member, MORS Fellow)
- Annie Patenaude (WG 2 Synthesis member, MORS Fellow)
- Crash Konwin (WG 3 Synthesis member, Booz Allen)
- Fred Hartman (WG 4 Synthesis member, MORS Fellow)
- Dr. Cy Staniec (WG 5 Synthesis Member, MORS Fellow)
- Joe Bobinis (WG 5 Synthesis Member, INCOSE Affordability WG, Lockheed Martin Senior Fellow)
- Frank Serna (NDIA SE Division Affordability WG)



## **Additional Findings: Synthesis Group**

- **Inflexibility of performance requirements inhibits the pursuit of affordability.**
  - ❖ The functional proponents frequently provide minimum performance parameters that may be either beyond the laws of physics or unattainable from a fiscal perspective.
  - ❖ If fixed point standards are relaxed to a performance range, then the range may provide the opportunity to radically reduce the development and procurements costs of a given system – while still meeting the fundamental mission needs.
- **Inaccurate costs can lead to bad affordability trades.**
  - ❖ Inaccurate / incomplete costs and bad decisions (i.e., decision makers not reviewing / not believing cost estimates) can lead to bad affordability trades.
  - ❖ The trade space can be unnecessarily limited by incomplete and imperfect costing