Teamed for Success

The Imperative for Aligning Systems Engineering and Life Cycle Logistics

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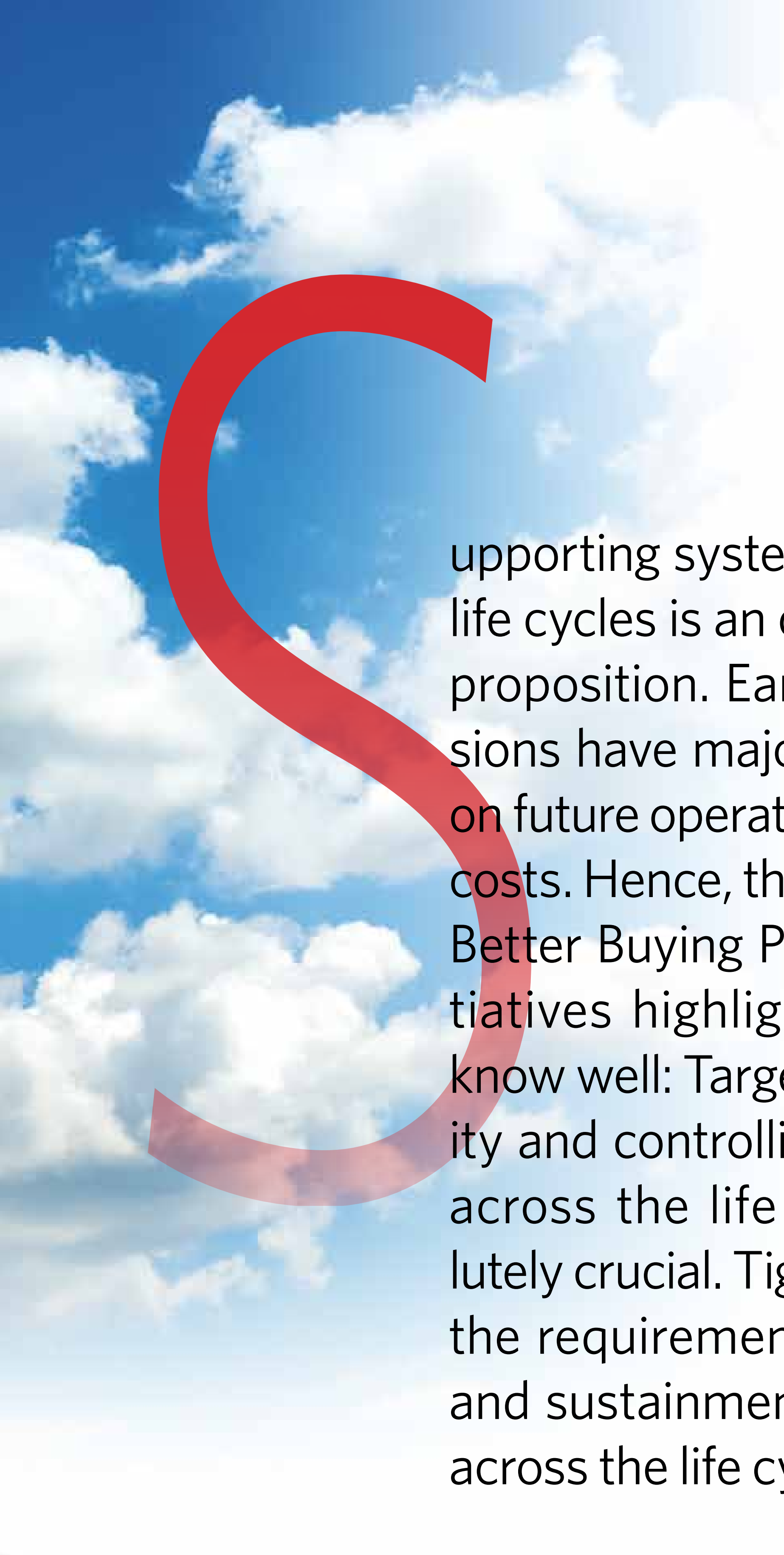

Supporting systems across their life cycles is an often expensive proposition. Early design decisions have major ramifications on future operating and support costs. Hence, the Department's Better Buying Power (BBP) initiatives highlight what we all know well: Targeting affordability and controlling cost growth across the life cycle is absolutely crucial. Tight alignment of the requirements, acquisition, and sustainment communities across the life cycle is essential.

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Given our common commitment to life cycle management (LCM), shared technical competencies, and collective responsibility to develop, field, and sustain affordable and effective weapon systems, the Life Cycle Logistics and Systems Engineering communities are—and by definition must be—inextricably linked. It is thus imperative that members of each recognize and understand what the other is all about. A few thoughts follow on the matter for members of both functional communities to ponder.

Starting with our systems engineering colleagues, here are 10 key life-cycle logistics, product support, and system sustainment tenets to be cognizant of:

Decisions You Make Will Be Felt for the Life of the System

Early engagement with your life-cycle logisticians is crucial. Participate in and support the development of and updates to the Life Cycle Sustainment Plan (LCSP). A vast majority of a weapon systems' total ownership costs are determined by decisions made early in the life cycle, which have profound ramifications for long-term product support and sustainment strategy development. As the director of the Cost Assessment and Program Evaluation (CAPE) so eloquently said, "The cost of operating and maintaining a system over its useful life is driven primarily by system design and reliability & maintainability decisions, which are typically made before production."

Design Systems with Supportability in Mind

Open systems architecture, well thought out technical data management strategies, continuous modernization, technology insertion, reliability centered maintenance, prognostics and health management, advanced diagnostics, and embedded training, are among many powerful supportability enablers. In fact, some would contend that along with Product Support Management and Design Interface and Sustaining Engineering are two of the most critical Integrated Product Support (IPS) Elements. Read through the JCIDS Manual "Guide for the Sustainment KPP" to better understand the nuances of the life-cycle sustainment outcome metrics—availability (materiel availability and operational availability), materiel reliability, ownership cost, and mean downtime. And don't forget that for the life cycle logistician, system design decisions can dictate maintenance, facilities, packaging, handling, storage and transportation, and supply support requirements, which in turn lead to support equipment, technical manual and training requirements. The integrated product support elements are "integrated" for a reason!

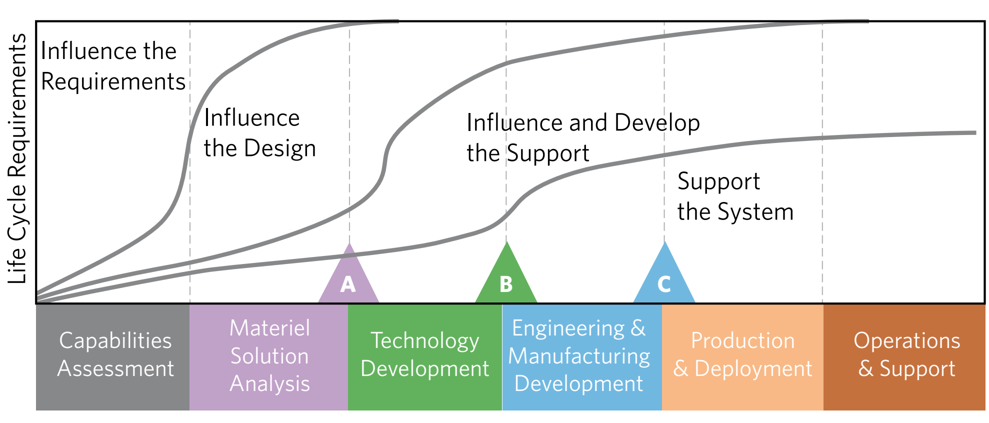
We Share More in Common Than You May Think

Life-cycle logisticians and systems engineers share multiple key technical competencies, including supportability analysis, reliability and maintainability analysis, technical/product data management, and configuration management, to name just a few. Numerous Defense Acquisition University training courses have been collaboratively developed and designed for students from both communities, including LOG 103–Reliability, Availability and Maintainability, LOG 204–Configuration Management, the new LOG 211–Supportability Analysis, and a Technical Data Management course now being planned for the future. As one of my systems engineering colleagues sagely observed, "This is akin to a three-legged race that our two communities must run together." In many respects, it's perhaps more appropriate to even call it a "three-legged marathon." Either way, successful life-cycle logisticians and systems engineers must serve together in lock-step!

Supportability Analysis and Maintenance Planning Really Matter

Supportability planning and executions are alive and well in both communities. The Supportability Analysis process informs and drives virtually every other logistics, product support, and sustainment decision and outcome that follows. It is arguably the linkage between user requirements and delivering supportable, sustainable weapon systems to our warfighters. Understanding not only how to conduct the analysis, but the ramifications of the decisions made during the process are essential to truly fulfilling the DoD Directive 5000.01 life-cycle management mandate. Understanding the linkages, interrelationships, inputs and outputs, and implications of the entire process—including product support requirements analysis, functional analysis, trade-off analysis, failure modes effects and criticality analysis (FMECA), fault tree analysis (FTA), reliability and maintainability allocation, modeling, prediction and analysis, reliability centered maintenance (RCM), and condition-based maintenance (CBM+), level of repair analysis (LORA) and maintenance task analysis (MTA)—is critical, as all are integral aspects of a supportability analysis

Figure 1. Supportability Analysis and the Life Cycle Management Framework

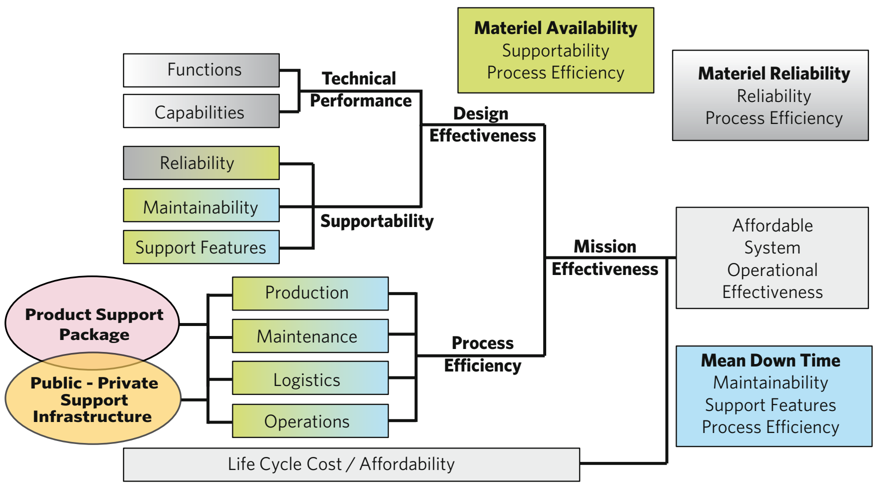


process that ultimately ensures our weapon systems are operationally suitable and sustainable.

It's All About the Warfighter

People are part of the system, and Human Systems Integration (HSI) matters. Think about how the human operates, interfaces with, and will actually use a weapon system. With experience, knowledge, skills, and abilities in mind, remain aware of what we're asking our young Soldiers, Sailors, Airmen, and Marines to do to support and maintain our weapon systems in the field—and in what environment they must do it. Take the time to talk to the users of the system. Understand the interrelationship between the system, its support system, and the personnel who must support, sustain, and maintain it. Take the CLE 062–Human Systems Integration continuous learning module. Maintainability and accessibility are important considerations throughout the design and development process. Organizational level maintenance is performed in all weathers, often in austere environments, and frequently in dark, hot, dusty, cramped, and otherwise difficult locations. Operators and maintainers very often operate in bulky protective gear, which also must be considered during systems design. And, by the way, weapon systems have a fascinating tendency to be operated and employed in environments and conditions and at rates that somehow seem to be different than originally anticipated. Plan on it. Incorporate it into your programmatic sustainment and risk mitigation strategies. As the old expression goes, "Your mileage may vary."

DAG Figure 4.4.F1. Affordable System Operational Effectiveness (ASOE) Diagram



More is Not Necessarily Better

Logistics is not merely ensuring the right parts at the right place at the right time. It's about designing suitable systems to be sustainable, maintainable, reliable, affordable, and transportable. It's also about developing and fielding supportable systems including ensuring mission capability of aging legacy systems. It's about designing, maintaining, and modifying systems to continuously reduce the demand for logistics. Parts management, standardization, use of common components, and enhancing energy efficiency are powerful enablers, and each can directly impact future logistics footprint requirements. Seek to avoid proliferation of peculiar support equipment wherever possible, and instead look to leverage as much common support equipment, and common hand tool requirements as possible. Each of these in turn will have profound ramifications on future maintenance requirements and operations and support cycle costs—often for many decades into the future.

Technical Data are More Than Engineering Drawings

The vast majority of acquisition professionals intuitively know this, of course, but it is worth collectively reminding ourselves every now and again. MIL-STD-31000 Technical Data Packages defines the Technical Data Package (TDP) as "A technical description of an item adequate for supporting an acquisition strategy, production, and engineering and logistics support." The description defines the required design configuration or performance requirements, and procedures required to ensure adequacy of item performance. It consists of applicable technical data such as models, drawings, associated lists, specifications, standards, patterns, performance requirements, quality assurance provisions, software documentation, and packaging details. Because nearly every acquisition discipline has a role to play and stake in technical data development or management, you are encouraged to check out Chapter 7 of the *DoD IPS Element Guidebook* (https://acc.dau.mil/ips-guidebook) for further insights.

Life Cycle Management is a Shared Responsibility

Life-cycle management (Figure 1), while officially a responsibility of the program manager, is key for systems engineering and life-cycle logistics as well. As the *Defense Acquisition Guidebook (DAG)* so eloquently states, "A life-cycle approach to system planning, development, and sustainment is fundamental to systems engineering." The integrated, multifunctional, interdisciplinary nature of life-cycle management is clearly illustrated in the *DAG*, which states that life-cycle management encompasses "Single point of accountability, evolutionary acquisition, modifications and upgrades, supportability and sustainment as key elements of performance", including "... performance-based strategies, including logistics, increased reliability, improved maintainability, and reduced logistics footprint, and continuing reviews of sustainment strategies." In case you were wondering, these words came directly from the systems engineering chapter of the *DAG*, although they could just as easily (and appropriately) have come from the logistics chapter. Shared, integrated, cross-functional ... where have we heard those words

> **"Life Cycle Logistics spans the entire system life cycle from concept to disposal, encompassing both acquisition logistics and sustainment activities, and includes professionals responsible for planning, development, implementation, and management of effective and affordable weapons, materiel, or information systems product support strategies.**
>
> —DAU Catalog

before? With this in mind, the 12 Integrated Product Support (IPS) Elements are similar to any another tactical mission thread through the system. You can't leave out one part of the thread and have the Technical Performance Measurements (TPM) of the other 11 have real meaning.

Performance Based Life-Cycle Product Support (PBL) is a Powerful Force Multiplier

Speaking of performance-based strategies, PBL is a big deal. Defined as "An outcome-based product-support strategy that plans and delivers an integrated, affordable performance solution designed to optimize system readiness," when properly applied, PBL support strategies have repeatedly demonstrated the ability to improve system availability, drive reliability improvements, enhance warfighter support, tackle process inefficiencies, proactively mitigate obsolescence and diminishing manufacturing sources and material shortages issues, and reduce operating and support costs in the process. According to a recent *Defense AT&L* magazine article, "The Department spends more than $90 billion on sustainment every year. A conservative estimate of savings that could result from broadly transitioning to PBL sustainment across the DoD ranges from 10 percent to 20 percent—every year!" This compelling data is an important reason the Under Secretary of Defense for Acquisition, Technology and Logistics said in his recent "Endorsement of Next-Generation Performance-Based Logistics Strategies" memo that "Appropriate use of Performance-Based Logistics will help to achieve affordable sustainment strategies and is a method for achieving our Better Buying Power goals." Systems engineering in general, and sustaining engineering in particular are integral to designing, developing, fielding, and executing your program's long-term weapon system product support strategy.

Demand Excellence

Make your life-cycle logistics and Product Support Manager (PSM) colleagues part of your team, and, at the same time, be an integral part of theirs. Coach them, mentor them, and facilitate their understanding of the systems engineering process—and why it matters. While they may not necessarily always be technical experts, or even have a systems engineering background, ensure that they are part of key system design and design trade decisions, technical reviews, and configuration management decisions. Remember: We're all in this together. Engage and challenge each other. Keep it simple. Collaborate. And perhaps most important of all, communicate, communicate, and communicate!

This is by no means a one-way street. There is much about systems engineering that life cycle logisticians and product support managers need to be aware of as well, including:

Logisticians are Part of the Systems Engineering Process

Realize it or not, the *DAG* makes it clear that life cycle logisticians have a direct role in the systems engineering process, stating "Participants in systems engineering include but are not limited to … (the) Program Office Level Lead Logistics Manager" and that "… systems engineering is typically implemented through multidisciplinary teams of subject matter experts (SMEs), including the life-cycle logistician." Successful life cycle logisticians must therefore understand basic systems engineering practices, processes, and principles. We must understand the integrated nature of key programmatic technical activities, deliverables, and outcomes.

To Be a Successful Life Cycle Logistician, You Must Understand the Tenets of Systems Engineering

Designing for support is a foundational aspect of our business, and you simply cannot successfully serve in this capacity without a basic understanding of systems engineering processes. Among several other reasons, this is why the course SYS 101–Systems Program Research, Development and Engineering Fundamentals is a mandatory Life Cycle Logistics Defense Acquisition Workforce Improvement Act training requirement. Don't stop there, however. Take other systems engineering courses and continuous learning modules offered by the Defense Acquisition University. Read *DAG* Chapter 4. Because "Systems engineering offers a technical framework to enable sound decision making relative to trade studies, system performance, risk, cost, and schedule," one of your many critical roles and responsibilities is to collaboratively support, advise, and actively engage with your systems engineering (and program management) colleagues in key systems design decisions. When design trades are being made, you need to be there as a credible subject matter expert. Speak the language, and understand your roles and responsibilities in the process.

A Single Integrated Team

Early, regular, and continuous engagement with your systems and sustaining engineers is crucial. Tackle the tough issues together. Strategize as a team. Bounce ideas off of each other. Participate in and support the development of and updates to the Systems Engineering Plan (SEP), and seek to facilitate reciprocal engagement and support in crafting, updating, and implementing the Life-Cycle Sustainment Plan (LCSP). The SEP and LCSP are not stand-alone documents that can be developed and executed in isolation, any more than they can be divorced from the system Acquisition Strategy, Technology Development Strategy, Test and Evaluation Master Plan, or any one of the myriad other required systems acquisition documents. As the *DAG* points out, because "A life-cycle approach to system planning, development, and sustainment is fundamental to systems engineering", " … under the life-cycle management concept, systems engineering should frame the decision making for sustainment logistics." Acquisition is a team sport, and the logistics and engineering communities play for the same team.

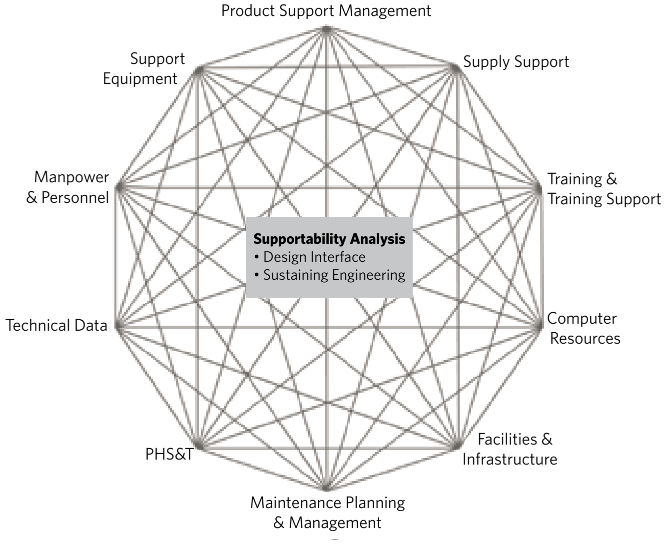
Reliability and Maintainability (R&M) Really Matter

R&M are key inherent system design characteristics. Subsequent product support, sustainment, logistics footprint, and indeed operations and support cost requirements are largely a result of these key design decisions. R&M allocation, modeling, prediction, analysis, assessment, and identification of corrective actions are critical aspects of the supportability analysis and sustaining engineering processes. Understand not only how R&M are derived, but why, when, by whom. Take ownership for your professional development in this realm. Oh, by the way, re-read the pearls of wisdom for the engineers on this subject in the section above titled "Decisions You Make will be Felt for the Life of the System." Participate in engineering trade studies. Systems engineers frequently have to trade off requirements, reliability vs. system operational performance, for example. By providing to the systems engineers quantitative data which objectively capture the key elements of the trade decision, you can help ensure superior outcomes when difficult design choices have to be made.

The Integrated Product Support (IPS) Elements are Integrated for a Reason

Why do so many life-cycle logistics expert practitioners believe that, along with product support management, the Design Interface and Sustaining Engineering elements are the most critical elements. Think about it for a moment. Where do maintenance requirements originate? Supply requirements? Transportation? Packaging? Training? Support equipment? They all link back first and foremost to the original system design, which ultimately translates warfighter requirements as articulated through the Availability Key Performance Parameters (KPP), Reliability and Cost Key System Attributes, and the Mean Downtime sustainment outcome metrics.

DAG Figure 5.1.1.F1. Linkage Between 12 Integrated Product Support (IPS) Elements



Logisticians Serve as Key Interdisciplinary Integrators

As the logistics expert, very often you will be called upon to serve as the systems and sustaining engineer's eyes and ears to the health of the supply chain, including maintenance, supply, and transportation issues. You often will be aware early of supportability, availability, and reliability issues through engagement with the warfighters, testers, and our industry partners, and can proactively engage your systems and sustaining engineering teammates sooner rather than later. The logistician's contact with the supply chain is vital to provide a heads-up on potential counterfeit parts, corrosion control, obsolescence, or diminishing manufacturing sources and material shortages, not to mention conveying to your engineering colleagues the importance of parts management, especially what parts are already in the inventory so the engineers don't design a new part that is already in the supply system. While there always will be some unique applications requiring specific designs, we don't need, nor can we afford, 250 different types of the essentially the same part! To succeed, however, systems/sustaining engineers and life-cycle logisticians must engage in frequent, if not constant, dialogue.

Know What is Expected of You During Key Program and Systems Engineering Technical Reviews

Be familiar with each of the technical reviews, their purpose, timing, entry criteria and expected outcomes, as well as your role and responsibilities as a member of the government program team. Several outstanding references to enhance your understanding include CLE 003–Technical Reviews and CLL 033–Logistician's Responsibilities During Technical Reviews continuous learning modules, *DAG* Figure 5.1.1.F1, which depicts the sustainment thread in the defense acquisition management system, and the very handy Technical Review Slide Rule, Program Review Checklists, and the Technical Review Checklists, which are available at https://acc.dau.mil/setools.

Understand and Implement Risk Management Across the Logistics

Domain. Risk management, according to *DAG*, "Is the overarching process that encompasses identification, analysis, mitigation planning, mitigation plan implementation, and tracking …" and " … should begin at the earliest stages of program planning and continue throughout the total life cycle of the program." (There's that life-cycle management emphasis again!) It is " ... effective only if it is fully integrated with the program's systems engineering and program management processes ... " and " ... is accomplished through the identification of risk drivers, dependencies, root causes, and consequence management." Check out the risk management Community of Practice at https://acc.dau.mil/rm, as well as the CLM 017–Risk Management continuous learning module. Don't mistakenly assume risk management is merely a systems engineering process or responsibility. It is so critical, and so interdisciplinary in nature, that the DAG goes as far as to stress that "Risk management is critical to acquisition program success. Because risk can be associated with all aspects of a program, it is important to recognize that risk identification is part of everyone's job, not just that of the systems engineer or program manager."

"Systems engineering is an interdisciplinary approach and process encompassing the entire technical effort to evolve, verify and sustain an integrated and total life cycle balanced set of system, people, and process solutions that satisfy customer needs. The systems engineering processes should be applied during concept definition and then continuously throughout the life cycle."

—*Defense Acquisition Guidebook,* Chapter 4

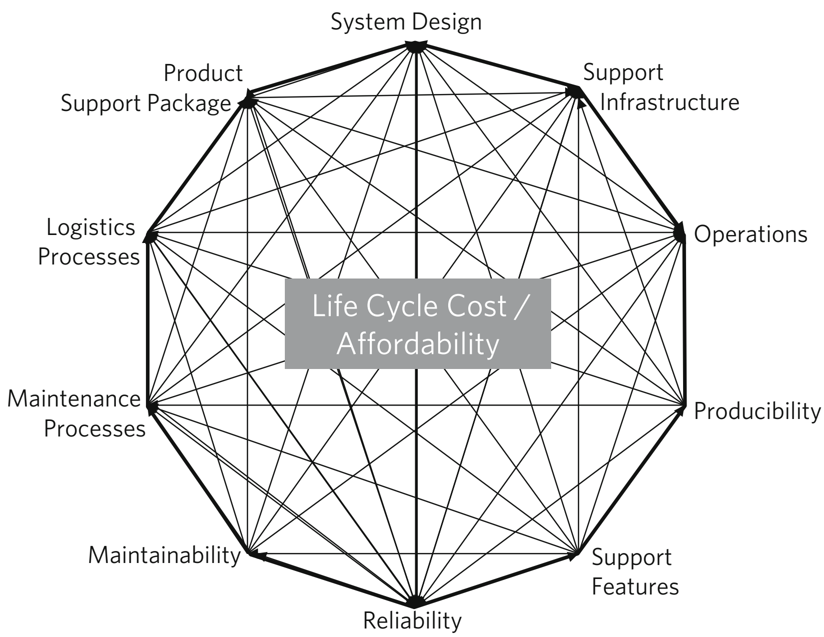
Link Systems Engineering Processes to Life Cycle Sustainment Outcomes

Read Section 5.2 of the *DAG*. Become familiar with the Affordable System Operational Effectiveness (ASOE) model (*DAG,* Figure 4.4.F1.) Take the time to understand its relationship to the product support strategy, supportability and system sustainment. The ASOE Model, " ... provides a framework that describes how design and process efficiencies relate to achieve mission effectiveness," and is achieved by influencing early design and architecture and focusing on supportability outputs (*DAG* Figure 5.2.F.3). Reliability, reduced logistics footprint, and reduced system life-cycle cost are achieved by being included from the very beginning of a program—starting with the definition of required capabilities. In all cases, full stakeholder participation is required in activities related to designing for support, designing the support, and supporting the design.

And Finally, If You Don't Already Have a Background in Systems Engineering ...

For our logisticians, if you don't have a mentor in SE, get one. The same goes for systems engineers who don't already have a life-cycle logistics mentor. Systems engineers should welcome—indeed, should demand—their life cycle logistics colleagues' participation in system design, development, manufacturing, and supporting engineering processes. Likewise, life-cycle logisticians must do the same for product support planning, implementation, and execution. And together, they must collaboratively conduct supportability analysis, drive reliability and maintainability into system design, jointly perform configuration management activities, leverage value engineering to improve system performance while reducing life-cycle costs, and manage technical and logistics product data.

DAG Figure 5.2.F3. Affordable System Operational Effectiveness Interrelationships



I would contend you simply cannot be a great systems engineer without understanding life-cycle logistics. Even though I am not an engineer, I would contend you also cannot be a great life-cycle logistician (or product support manager) without understanding systems engineering. Some might argue that, if this is indeed so, it should rationalize the formal establishment of a new logistics engineering or supportability engineering career field within the Defense Acquisition Workforce. Establishing new functional disciplines should not be construed as a panacea. Instead, developing qualified, capable, experienced, well-trained personnel possessing the right skill sets and experience, coupled with a vision of success, a passion for interdisciplinary integration, and an understanding of roles, responsibilities, and required outcomes of this business of ours is what is needed to carry the day.

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