



Life Cycle Sustainment: Accomplishing Performance Driven Outcomes through Condition Based Maintenance and Continuous Process Improvement

White Paper: Prepared by the Aerospace Industries Association Product Support Committee (AIA PSC) based on DoD Focus in Material Readiness/Continuous Process Improvement and AIA Industry Initiatives/Best Practices in Performance Based Life Cycle Sustainment and Supply Chain enabling capabilities.

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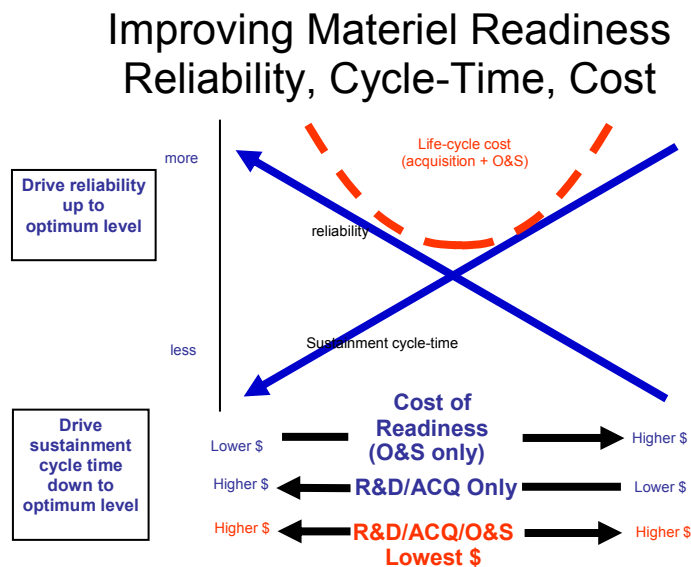
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II. Background

DoD logistics operations underpin the sustainment of military material readiness. These operations involve the efforts of over 1 million military service members and DoD civilians and are estimated to cost more than \$114 billion in FY 2006. DoD material readiness sustainment value streams range from the procurement of consumable parts for minor repairs to the overhaul of entire weapon systems. These value streams involve many diverse organizations, from large industrial activities to forward-deployed units (1).

DoD operations are being transformed to support emerging force application requirements, become leaner and more efficient, and embrace contemporary logistics support concepts. OSD has directed the development of a strategic approach for achieving and sustaining material readiness through continuous process improvement (CPI), utilizing standard CPI tools such as Lean, 6 Sigma and Theory of Constraints. Applied using proven tools like value stream mapping and focused meaningful metrics, incorporation of emerging comprehensive sustainment concepts such as Condition Based Maintenance Plus (CBM+), management of the Supply and Distribution Chain, and Sustaining Engineering/Life Cycle Integration- all in a Net-centric environment- can be accomplished. These initiatives can provide immediate weapon system benefits for improving material readiness, reliability, life cycle cost and cycle time, with or without proven interdependencies.



As the recent QDRs have focused upon the transformation to performance based initiatives and supply chain improvements, partnering with Industry has taken place in the organic maintenance depots and demonstrated effective and beneficial weapon system life cycle cost and performance improvements. Further transformation and collaboration between DoD and Industry is viewed as a positive way-forward to improve readiness of weapon systems to the Warfighter while utilizing proven and affordable Industry enabling capabilities.

(1) DoD Material Readiness Continuous Process Improvement Transformation Review, Report LR502T1, March 2006

III. Discussion

A. Recognizing that the defense community has a need for Material Readiness/CPI now

The adaptation of Lean and Six Sigma tools has already proven results in Industry and through Transformation reforms, is taking root in DoD. Application of CPI has delivered substantial benefits in maintenance operations and material reliability in US Army, USAF and USN land, air and sea systems. Cycle time reductions of over 50%, repair cost reductions of 25-30% and reliability improvements of 2-5 fold have been documented.

The DoD overall strategic approach to apply CPI across all operational activities has mandated organizational focus and training in the identification and use of CPI concepts, tools and techniques to improve the overall performance of DoD weapon systems. The identification of metrics for tracking and managing overall improvements that are linked to value stream elements is key to sustaining life cycle material readiness throughout DoD.

As opportunities or even impediments are identified by DoD organizations and activities in applying CPI techniques and approaches, Industry can be a valued participant to engage as part of the weapon system technical and business knowledge base to incorporate potential solutions and best practices.

Properly incentivized through performance based contracting vehicles, Industry can provide life cycle sustainment improvements that yield year-on-year DoD operational cost reductions while providing industry with time based ROI opportunities, through application of proven CPI capabilities at acceptable levels of risk.

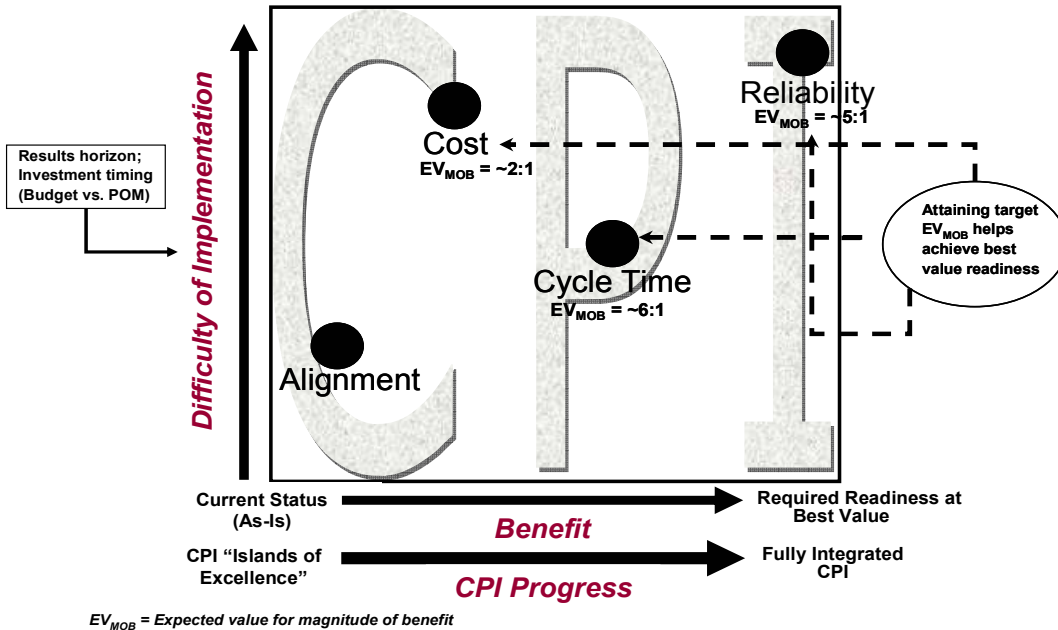
B. Addressing key Warfighter metrics as necessary outcomes to the life cycle sustainment approach

Alignment of Warfighter metrics is critical to effective CPI implementation whereas integration of the supply chain is necessary to accomplish the benefits of DoD enterprise end-to-end management. Typically, the supply chain enterprise is complex and therefore will benefit organizationally by alignment of metrics that meet warfighter readiness while maintaining flexibility.

Key Warfighter Metrics within DoD for weapon system operational effectiveness have been observed to include:

- Material Availability as a measure of operational readiness within a given asset population
- Material Reliability as a measure of probability of an asset to perform its intended function over time without failure
- Ownership Cost as a measure of all O&S costs incurred associated with the asset
- Cycle Time as a measure of repair time or mean down time an asset incurs to be returned to operational status

Applying Continuous Process Improvement (CPI) in each area in an integrated manner achieves best performance based outcomes



(2)

C. Value Stream mapping and analysis

As the DoD enterprise is considered to be complex in functions and interfaces, end-to-end value stream mapping and analysis becomes an effective tool for assessing organizational impacts and activities. Planning and budgeting of resources in order to accomplish life cycle sustainment is essential in meeting Warfighter needs and operational effectiveness.

Material readiness and CPI transformation require that enterprise-wide value stream mapping and analysis be performed to identify improvement opportunities, develop successful implementation plans, and align operational improvements to consistent metrics, assuring that improvements and efficiencies are realized.

Involving key organizational entities end-to-end to include Industry is crucial to this success. Focusing desired results to Key Warfighter Metrics and Performance Driven Outcomes aligns the goals of DoD with capability and enablers that Industry can apply.

D. Life cycle sustainment capability focus areas

AIA Industry represents a broad spectrum of weapon system and platform based life cycle sustainment experience, in both military and commercial areas. AIA committees represent the functional life cycle and are structured to collaborate and support interests while staffing expertise in the following areas:

- Product Support
- Engineering Management
- Electronic Enterprise Integration
- Procurement and Finance
- Supplier Management
- Quality Assurance
- Space Systems
- Civil Aviation
- National Security

The AIA Product Support Committee is positioned and prepared to collaborate within AIA and other necessary professional associations to mutually develop and assist DoD with approaches in identifying technology, process and standards in the following life cycle sustainment capability focus areas:

- Life Cycle Modeling
- Information Management Systems/Data Standards
- Condition Based Maintenance Plus to include RCM, Maintenance Planning, Prognostics/Diagnostics
- Supply Chain, Distribution and DMSMS
- Sustaining Engineering and Life Cycle Integration

These areas will be discussed further as to focus, initiatives and opportunities in the next section.

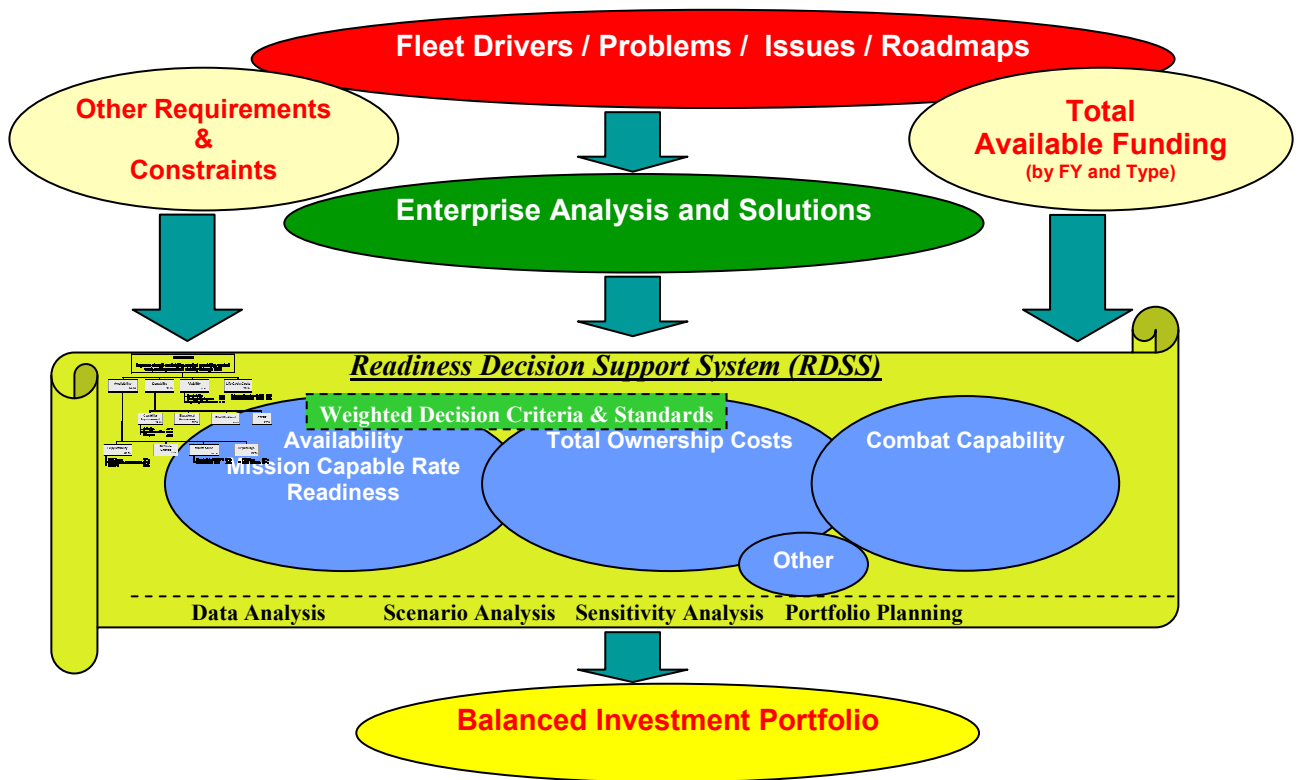
IV. Opportunities

A. Life Cycle Modeling

A variety of information modeling tools and processes exist throughout DoD and industry to forecast outcomes for life cycle management. These models are useful in analyzing and forecasting product/systems related technical and performance data focused on reliability, cost, investment and risk in performance based outcomes.

AIA and OSD have launched an initial assessment of life cycle modeling approaches by examining traditional data development processes and delivery tools related to life cycle product, business and O&M data. A mapping and framework analysis is being performed to identify benefits, gaps and constraints related to the effective and consistent use of data by the affected communities of practice impacting analysis and cost trade decisions to improve readiness and performance. The initial analysis and deliverable is envisioned to provide an enterprise framework for a notional Readiness Decision Support System and recommended requirements for detail follow-on project definition.

The Framework for “Decision Support System”



B. Information Management Systems/Data Standards

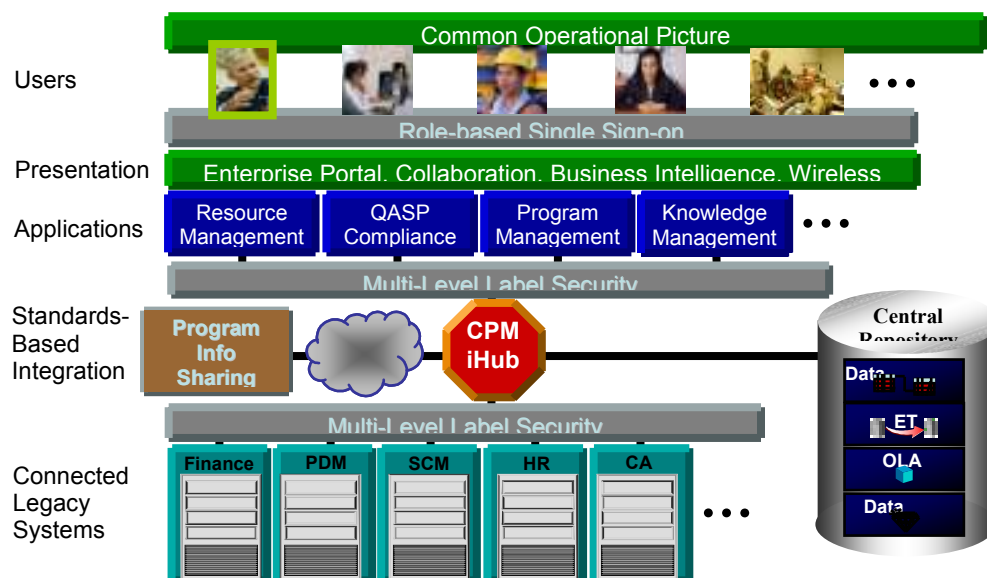
AIA and DoD have conducted a joint project seeking to bring together relevant pieces of the community to identify best practices and processes for structuring and transferring data and data files for product data. Many different trade associations and technical user groups are developing data standards to define common data structures or “metadata” for the different types of product data, i.e. CAD files, manufacturing, configuration management, transportation, electronic technical manuals, diagnostics and prognostics, and other logistics functions.

An initial review of the state of maturity and existence of these data standards in the aerospace and defense community was conducted and finalized in Feb 2006. The results indicate that, on a community scale, no standards at that time were globally adopted but, there are several standards close to maturity with significant adoption. What remains is for the technical and user communities to agree on the best standards and adopt them into practice.

The end result must be to “Connect the Community”, i.e. Government and Industry users identify requirements for data management to the technical development groups - who then provide accepted product data standards to software tool developers - who in turn incorporate these standards into their products. The users and suppliers can then use the respective software tools to manage data in an interoperable end state. The ultimate outputs of this effort will be lower life cycle costs for product data, better quality data, and better opportunities to further automate and streamline data management processes.

The final recommendations of this joint project will be published under separate cover in December 2006. The way forward will address industry and DoD working together to agree on a common data environment and business model implementation approach that demonstrates use of data structure and standards that can be piloted by DoD in selected programs.

Identifying a Solution Architecture



C. Condition Based Maintenance Plus

Condition Based Maintenance Plus (CBM+) transforms the traditional dual approach of fault based restorative actions and RCM developed scheduled maintenance to a lean predictive philosophy based on impending need, captured through prognostic capabilities and monitoring systems. The traditional RCM approaches are valid but the questions posed during the process must take into account continuously improving capabilities in impending failure detection as well as more accurate fault isolation. The goal is lean out maintenance planning that will allow increasingly targeted scheduled maintenance with the ultimate goal of performing maintenance and inspections only upon some evidence of need. Achieving this goal requires confidence in the diagnostic/prognostic capabilities employed within weapon systems so that entities charged with airworthiness decisions will be willing to let go of current maintenance schemes. Invasive scheduled inspections and preventative maintenance can lead to increased failure and induced damage.

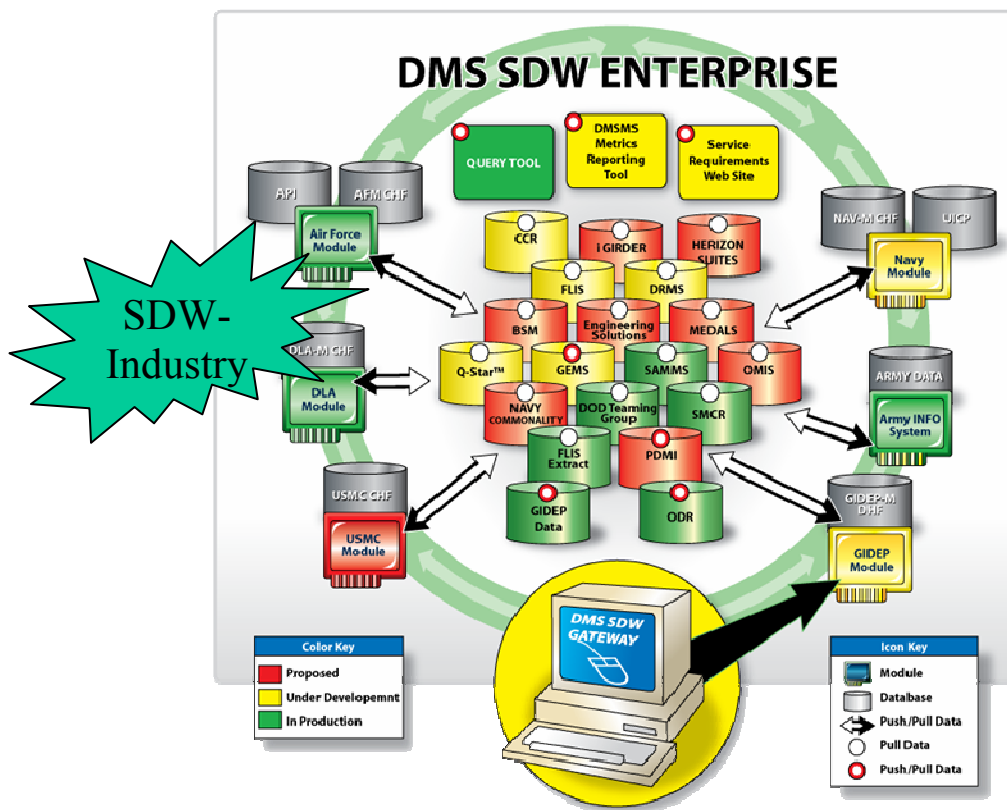
One approach to developing confidence to lean out maintenance is a standard evaluation process for applied diagnostic and prognostic capabilities. Using proven six sigma techniques for capturing the critical elements, AIA can work with our Service counterparts to ensure necessary gates are passed and instill certainty of the maintenance planning with the airworthiness authorities. AIA, working with DoD, could develop a standard that defines the process necessary for successful employment of current and emerging technologies for CBM+. Furthermore, significant learning gains are needed whereas many technical challenges exist to include obtaining near real-time data, designing/retrofitting PHM related hardware and making the data net-enabled and available throughout the government/industry value stream to name a few.

D. Supply Chain/Distribution/DMSMS

As the Distribution Process Owner (DPO), TRANSCOM serves as the single entity to direct and supervise execution of the Strategic Deployment system to improve the overall efficiency and interoperability of distribution-related activities: deployment, sustainment, and redeployment support during peace-time and war. With this aim in mind, TRANSCOM is partnering with DLA to combine an Integrated Data Environment (IDE) with the Global Transportation Network (GTN) in order to provide seamless logistics, distribution, and transportation services to the warfighter. The impact of this combined IDE/GTN on the way Industry supports DoD, as well as on how the individual Services support their forces in the field, should be jointly examined for the opportunity to explore technology applications (ie RFID) and commercial best practices in distribution and total asset visibility, to identify opportunities to expand end-to-end seamless integration.

D. Supply Chain/Distribution/DMSMS(cont`d)

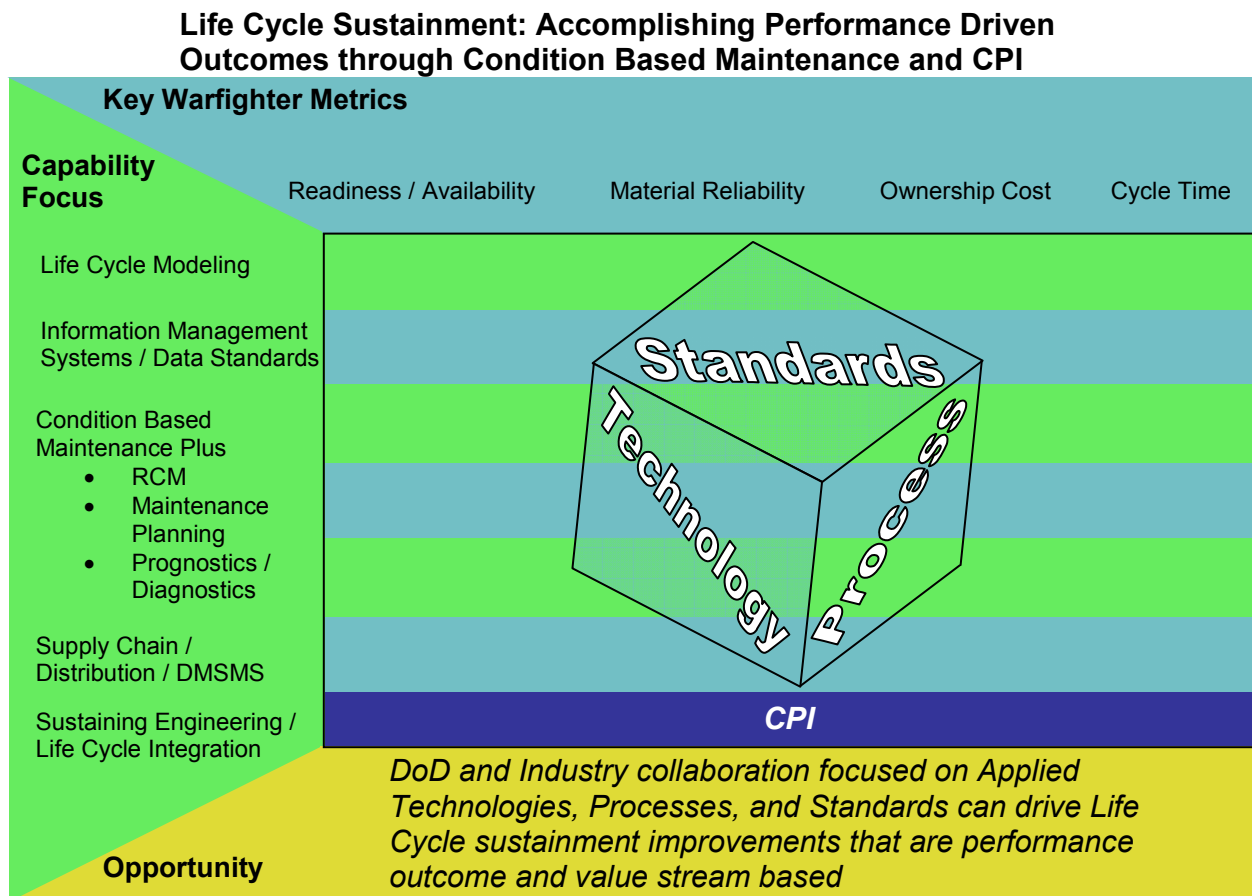
Relating to Diminishing Manufacturing Sources and Material Shortages(DMSMS), OSD/DoD have focused resources with dramatic and cost effective results in DMSMS initiatives, such as the Government Industry Data Exchange Program(GIDEP) to include Shared Data Warehouse(SDW) and the DMSMS knowledge sharing portal(DKSP). DMSMS SDW and exchange programs are being knowledge managed at a useful volume of over 200,000 items per year and have avoided billions in additional NRE and testing should repair parts or substitutions not be located when needed. AIA Industry and DoD should continue to collaborate and provide useful exchange forums whereas knowledge sharing and expanded participation within the DMSMS data resources and hosted workshops and conferences are accomplished.



E. Sustaining Engineering/Life Cycle Integration

DoD and Industry should strive to raise the level of awareness of life cycle integration/sustaining engineering importance required in the transformation of weapon systems to performance based outcomes. DoD and DAU continue to focus this in the area of Acquisition Excellence Guidance, logistics education for PM/SYSCOMS and DoD wide CPI, while also working collaboratively with Industry to maintain Systems Engineering specifications and standards that embrace emerging life cycle requirements. This is of particular importance in the system design and sustainment integration practices for reliability, maintainability, supportability, affordability and safety.

It would be considered of significant benefit to convene a professional forum of DoD, Industry, Professional Associations and Academia to address standards and specifications in their current state and further examine collective ideas for capturing and incorporating best practices. It is envisioned that a sanctioned working group could be convened as necessary to continually assess, draft and input to recognized and agreed specifications and standards, providing a more collaborative and meaningful community of knowledge to leverage and institutionalize best life cycle integration and sustaining engineering practices.



V. Conclusions and Recommendations

The state of Transformational Acquisition and Evolutionary Logistics for improved readiness and sustainment to the Warfighter can be advanced by taking further collaborative steps and actions by DoD and Industry, when focused on performance driven outcomes. Applying CPI through emerging best practices and enabling technologies such as Condition Based Maintenance can produce dramatic increases in material readiness to the Warfighter while providing DoD significant operational cost reductions and improved financial returns for Industry.

This paper, generated with these joint principles in mind, has identified areas of opportunity underway and subject to further government/industry examination whereas the understanding of benefits and improvements has documented results in both defense and commercial applications. The particular Capability Focus areas where joint opportunity exists have been highlighted and in some cases have already jointly accomplished initial and meaningful work.

Therefore, the recommended path forward by area is as follows:

- A. Life Cycle Modeling- Complete the initial joint analysis and framework for the Readiness Decision Support System with recommended requirements for follow-on development in 2007.
- B. Information Management Systems/Data Standards- Deliver the joint Net Centric Information Systems Common Data Environment project recommendations in December 2006 with anticipation from OSD/DoD of a recommended way-forward to launch and implement selected pilot programs beginning in 2007.
- C. Condition Based Maintenance Plus- Jointly explore with OSD/DoD the establishment of a working group in early 2007 to examine CBM+, RCM, prognostics and diagnostics as to the current community state of practice and recommend updates and/or further development of a standard evaluation process for improvements to maintenance planning while elevating lean predictive practices beyond traditional approaches.
- D. Supply Chain/Distribution/DMSMS- Jointly explore with TRANSCOM and DLA the Integrated Data Environment and Global Transportation Network to evaluate the seamless integration into the OEM supply chain, further capturing commercial best practices in distribution and total asset visibility. Pertaining to DMSMS, AIA Industry and OSD/DoD should establish a joint working group to develop a go-forward plan of action and exchange forums to expand the application and use of DMSMS data bases and resources, as well as the IDE/GTN initiatives.
- E. Sustaining Engineering/Life Cycle Integration- Jointly convene a professional forum in 2007 of DoD, Industry and Academia to address the emerging state of life cycle integration and sustaining engineering requirements and practices as related to Systems Engineering specifications and standards. Determine the on-going need to collaborate and provide a meaningful community of knowledge to leverage and institutionalize best practices.